CALIFORNIA STATE MINING BUREAU

FERRY BUILDING, SAN FRANCISCO

FLETCHER HAMILTON State Mineralogist

San Francisco] BULLETIN No. 90 [August, 1921

CALIFORNIA MINERAL PRODUCTION FOR 1920

WITH COUNTY MAPS

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO, 1921

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BY

WALTER W. BRADLEY

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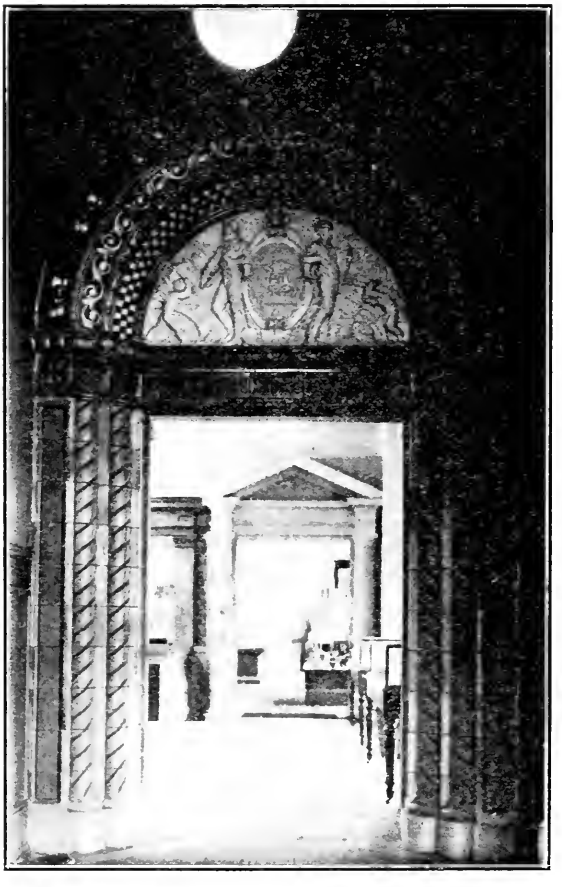


Exhibit of California structural materials in State Mining Bureau, Ferry Building, San Francisco.

CONTENTS.

CHAPTER IV.

CHAPTER V.

CHAPTER VI.

CHAPTER VII.

APPENDIX.

ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

September, 1921.

To His Excellency, The Honorable William D. Stephens,
Governor of the State of California.

Sir: I have the honor to herewith transmit Bulletin No. 90 of the State Mining Bureau, being the annual report of the statistics of the mineral production of California.

The remarkable variety, total valuation, and wide distribution of many of our minerals revealed herein show California's importance, both in peace and in war, as a producer of commercial minerals among the states of the Union.

Respectfully submitted.

Fletcher Hamilton,
State Mineralogist.

LETTER OF INTRODUCTION.

It is the endeavor of the staff of the State Mining Bureau, in these annual reports of the mineral industries of California, to so compile the statistics of production that they will be of actual use to producers and to those interested in the utilization of the mineral products of our state, while at the same time keeping the individual's data confidential. In addition to the mere figures of output, we have included descriptions of the uses and characteristics of many of the materials, as well as a brief mention of their occurrences.

The compilation of accurate and dependable figures is an extremely difficult undertaking, and the State Mineralogist takes the opportunity of here expressing his appreciation of the cooperation of the producers in making this work possible. A fuller appreciation of the value of early responses to the requests sent out in January will result in earlier completion of the manuscript. Statistics lose much of their value if their publication is unnecessarily delayed.

Some of the data relative to properties and uses of many of the minerals herein described are repeated from preceding reports, as it is intended that this annual statistical bulletin shall be somewhat of a compendium of information on California's commercial minerals and their utilization.

FLETCHER HAMILTON,
State Mineralogist.

MINERAL INDUSTRY, CALIFORNIA, 1920

DATA COMPILED FROM DIRECT RETURNS FROM PRODUCERS IN ANSWER TO INQUIRIES SENT OUT BY THE CALIFORNIA STATE MINING BUREAU, FERRY BUILDING, SAN FRANCISCO, CALIFORNIA.

CHAPTER ONE.

Mineral output in California during the year 1920 amounted to the sum of $242,099,667 worth of crude materials. There were fifty different mineral substances, exclusive of a segregation of the various stones grouped under gems; and all of the fifty-eight counties of the state contributed to the list.

As compared with the 1919 output, the notable features of 1920 are: The continued increase in petroleum valuation; the decreases in the metals group; and increases in the structural and 'industrial' groups. The net result was an increase of $46,269,665 over the grand total value of the year 1919, of which increase, petroleum accounted for more than 75 per cent.

The metals group was the only one as a whole showing a net decrease, being due mainly to gold, copper, and quicksilver. Notable increases were registered by silver and lead.

An interesting feature of the returns is the status shown by the structural materials group. The total value for this group jumped from $16,796,784 to $29,723,405, due mainly to cement, 'miscellaneous stone' (crushed rock, sand and gravel), brick and tile, and magnesite, in the order named. This indicates a renewal of building and construction activity, which has been curtailed during the war period.

The 'industrial' group showed an increase in total value from $2,041,981 to $3,567,760. The more important items were diatomaceous earth, barytes, lithia and tale. In the salines group, there were important increases made by borax and soda, but which were nearly counterbalanced by a decrease of almost a million dollars by potash.

The figures of the State Mining Bureau are made up from reports received direct from the producers of the various minerals. Care is exercised in avoiding duplication, and any error is likely to be on the side of under- rather than over-estimation.

Caribou Power House, of the Great Western Power Company, Plumas County. Cut by courtesy of the company.

California yields commercially a greater number and variety of mineral products than any other state in the United States, and probably more than any other equal area elsewhere of the earth. Previous to 1916, the total annual value of her output was surpassed by but four other states, they being the great coal and iron producers of east of the Mississippi River. In 1916 and 1917, because of their enormous increases in copper output, Montana and Arizona passed California in total value for those years; and Arizona for 1918. Of one item, at least, borax, California still remains the sole producer; and for many years was also the sole domestic source of chromite and magnesite. We produce at least 75% of the quicksilver of the United States. For some years we have been leading all others in gold and platinum; while alternating in the lead with Colorado in tungsten, and with Oklahoma in petroleum.

Development of our hydroelectric resources in California is nowhere more important than in the mining districts. Some of the leading, large-unit installations are in close proximity to our important mineral regions. Electricity is destined to play an increasingly significant part in the economic development of our commonwealth and its natural resources. The halftone herewith is from a photograph of the most recent large-unit hydroelectric plant to be completed in California—the Caribou plant of the Great Western Power Company, in Plumas County.

According to published reports, California during 1920 was third in the United States in development of electric power, being exceeded by only New York and Pennsylvania. California, also, ranked second in the possession of potential water power, her resources in this item being greater than the entire group of Atlantic Coast states combined. Present installations total over one million horsepower.

The following table shows the comparative yield of mineral substances of California for 1919 and 1920, as compiled from the returns received at the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

Substance	1919		1920		Increase+ Decrease— Value
	Amount	Value	Amount	Value	
Asbestos	[1]	[1]	[1]	[3]	[3]
Barytes	1,501 tons	$18,065	3,029 tons	$20,795	$2,730+
Bituminous rock	4,614 tons	18,537	5,450 tons	27,825	9,288+
Borax	65,791 tons	1,717,192	127,065 tons	2,794,206	1,077,014+
Brick and tile		3,087,067		5,704,393	2,617,326+
Cement	4,645,289 bbls.	8,591,900	6,709,160 bbls.	14,962,945	6,370,955+
Chromite	4,314 tons	97,164	1,770 tons	43,031	54,133—
Clay (pottery)	135,708 tons	245,019	203,997 tons	440,689	195,670+
Coal	2,983 tons	8,203	2,078 tons	5,450	2,753—
Copper	22,162,605 lbs.	4,122,246	12,947,209 lbs.	2,382,303	1,739,943—
Dolomite	24,502 tons	67,953	42,388 tons	132,791	64,838+
Feldspar	1,272 tons	12,965	4,518 tons	26,189	13,244+
Fuller's earth	385 tons	3,819	600 tons	6,000	2,190+
Gems		5,425		36,056	30,631+
Gold		16,695,955		14,311,043	2,384,912—
Granite		220,743		495,732	274,989+
Graphite	[1]	[1]	[3]	[3]	[3]
Gypsum	19,813 tons	50,579	20,597 tons	92,535	41,956+
Infusorial and diatomaceous earths	40,200 tons	217,800	60,764 tons	1,056,260	838,460+
Iron ore	2,300 tons	13,796	5,975 tons	40,889	27,093+
Lead	4,139,562 lbs.	219,397	4,903,738 lbs.	392,300	172,903+
Lime	420,696 bbls.	552,043	463,144 bbls.	557,232	5,189+
Limestone	88,291 tons	248,145	90,120 tons	298,197	50,052+
Lithia	800 tons	14,400	10,046 tons	153,502	139,102+
Magnesite	44,693 tons	452,094	83,695 tons	1,033,491	581,397+
Magnesium salts	1,616 tons	82,457	3,150 tons	107,787	25,330+
Manganese ore	11,569 tons	451,422	2,892 tons	62,323	389,099—
Marble	25,020 cu. ft.	74,482	29,531 cu. ft.	92,899	18,417+
Mineral paint	1,780 tons	17,055	779 tons	8,477	8,578—
Mineral water	2,233,842 gals.	340,117	2,391,791 gals.	421,643	81,526+
Natural gas	52,173,503 M. cu. ft.	4,041,217	58,567,772 M. cu. ft.	3,898,286	142,931—
Petroleum	101,182,962 bbls.	142,610,563	103,377,361 bbls.	178,394,937	35,784,374+
Platinum	418 fine oz.	69,611	477 fine oz.	68,977	8,363+
Potash	28,118 tons	2,415,963	25,298 tons	1,465,463	950,500—
Pumice and volcanic ash	2,388 tons	43,657	1,537 tons	25,890	17,767—
Pyrite	147,024 tons	540,306	146,001 tons	535,581	9,719—
Quicksilver	15,200 flasks	1,353,381	10,278 flasks	775,527	577,854—
Salt	233,994 tons	893,963	230,638 tons	972,648	75,685+
Sandstone	5,400 cu. ft.	3,720	10,500 cu. ft.	2,300	1,420—
Silica (sand and quartz)	18,659 tons	101,600	25,324 tons	93,793	4,807—
Silver		1,240,051		1,859,896	619,845+
Soapstone and tale	8,764 tons	115,091	11,327 tons	221,362	106 271+
Soda	21,294 tons	721,958	32,407 tons	1,164,898	442,940+
Stone, miscellaneous[2]		3,698,944		6,803,557	3,104,613+
Tungsten concentrates	214 tons	219,316			219,316—
Zinc	1,384,192 lbs.	101,046	1,188,009 lbs.	96,229	4,817—
Unapportioned		[4]19,500		[3]15,340	4,160—
Totals		$195,830,002		$242,099,667	
Net increase					$46,269,665+

[1]Unapportioned—includes asbeston and graphite.
[2]Includes macadam, ballast, rubble, riprap, paving blocks, sand, gravel, and grinding-mill pebbles.
[3]Unapportioned—includes asbestos, graphite and columbite (tantalum ore).

The following table shows the comparative value of the mineral production of the various counties in the state, for the years 1919 and 1920:

County	1919	1920
Alameda	$1,304,685	$1,947,880
Alpine	100	840
Amador	3,173,588	2,010,200
Butte	481,537	641,562
Calaveras	1,978,558	1,880,050
Colusa	7,300	57,488
Contra Costa	1,395,558	2,082,053
Del Norte	7,240	11,781
El Dorado	166,152	186,432
Fresno	21,641,465	23,819,351
Glenn	59,637	134,707
Humboldt	52,011	159,796
Imperial	140,443	169,882
Inyo	2,692,546	3,889,400
Kern	66,625,352	89,121,581
Kings	51,283	29,870
Lake	39,375	63,553
Lassen	1,150	12,313
Los Angeles	23,606,381	26,975,163
Madera	117,888	122,925
Marin	228,974	335,745
Mariposa	262,566	271,031
Mendocino	14,214	26,110
Merced	40,683	24,800
Modoc	8,518	4,668
Mono	85,168	188,258
Monterey	148,504	126,449
Napa	275,903	230,141
Nevada	3,064,053	2,955,006
Orange	27,850,693	34,108,136
Placer	337,881	612,813
Plumas	2,158,196	2,082,662
Riverside	2,576,978	5,128,208
Sacramento	2,170,296	2,066,154
San Benito	1,276,476	1,483,024
San Bernardino	4,638,685	6,541,348
San Diego	342,662	794,229
San Francisco	65,541	80,353
San Joaquin	435,618	471,102
San Luis Obispo	212,430	405,604
San Mateo	241,671	283,163
Santa Barbara	7,594,917	10,538,611
Santa Clara	1,048,571	1,038,692
Santa Cruz	2,245,056	3,081,138
Shasta	2,776,803	1,108,538
Sierra	304,879	446,861
Siskiyou	486,042	229,115
Solano	1,672,084	2,930,614
Sonoma	286,038	287,245
Stanislaus	544,725	385,017
Sutter		54
Tehama	9,000	26,400
Trinity	571,649	562,105
Tulare	331,001	593,296
Tuolumne	671,493	513,914
Ventura	3,017,074	5,229,175
Yolo	25,466	9,472
Yuba	4,261,545	3,573,649
Totals	$195,830,002	$242,099,667

Total Production.

The following tabulation gives the total value of mineral production of California by years since 1887, in which year compilation of such data by the State Mining Bureau began. At the side of these figures the writer has placed the values of the most important metal and nonmetal items—gold and petroleum.

In the same period copper has also increased, beginning with 1897 following the entry of the Shasta County mines. Cement increased rapidly from 1902, while crushed rock, sand and gravel parallels the cement increase. Quicksilver has been up and down. Mineral water and salt have always been important items, but the values fluctuate. Borax has increased materially since 1896. Wartime increases, 1915–1918, were shown by chromite, copper, lead, magnesite, manganese, silver, tungsten and zinc, but all declined in 1919, with structural material, magnesite and silver increasing in 1920.

Total Mineral Production of California by Years, Since 1887.

Year	Total value of all minerals	Gold, value	Petroleum, value
1887	$19,785,868	$13,588,614	$1,357,144
1888	19,469,320	12,750,000	1,380,666
1889	16,681,731	11,212,913	368,048
1890	18,039,666	12,309,793	384,200
1891	18,872,413	12,728,869	401,264
1892	18,300,168	12,571,900	561,333
1893	18,811,261	12,422,811	608,092
1894	20,203,294	13,923,281	1,064,521
1895	22,844,663	15,334,317	1,000,235
1896	24,291,398	17,181,562	1,180,793
1897	25,142,441	15,871,401	1,918,269
1898	27,289,079	15,906,478	2,376,420
1899	29,313,460	15,336,031	2,660,793
1900	32,622,945	15,863,355	4,152,928
1901	34,355,981	16,989,044	2,961,102
1902	35,069,105	16,910,320	4,692,189
1903	37,759,040	16,471,264	7,313,271
1904	43,778,348	19,109,600	8,317,809
1905	43,069,227	19,197,043	9,007,820
1906	46,776,085	18,732,452	9,238,020
1907	55,697,949	16,727,928	16,783,943
1908	66,363,198	18,761,559	26,566,181
1909	82,972,209	20,237,870	32,398,187
1910	88,419,079	19,715,440	37,689,542
1911	87,497,879	19,738,908	40,552,088
1912	88,972,385	19,713,478	41,868,344
1913	98,644,639	20,406,958	48,578,014
1914	93,314,773	20,653,496	47,487,109
1915	96,663,369	22,442,296	43,503,837
1916	127,901,610	21,410,741	57,421,334
1917	161,202,962	20,087,504	86,976,209
1918	199,753,837	16,529,162	127,459,221
1919	195,830,002	16,695,955	142,610,563
1920	242,099,667	14,311,043	178,394,937
Totals	$1,237,809,051	$571,843,386	$989,234,426

Dividends.

Among the metal mine dividend payers in California the following have been reported:*

Company	Metal	Shares issued	Par value	Paid in 1921	Total	Latest dividends	
						Date	Per share
American S. & R. (Includes also properties in other states and Mexico.)	Copper, Lead, Gold, Silver, Zinc	[1]699,980 [2]500,000	$100 00 100 00	$69,980 1,750,000	$46,465,578 74,946,386	Mar. 15, 1921 June 1, 1921	$1 00 1 75
Argonaut	Gold	200,000	5 00	----------	1,980,000	Mar. 20, 1920	0 05
Atolia	Tungsten	100,000	1 00	----------	5,264,500	Dec. 14, 1918	0 50
Cerro Gordo	Lead, Zinc, Silver	1,000,000	1 00	----------	300,000	Jan. 15, 1918	0 05
Engels	Copper	1,791,926	1 00	----------	698,684	Oct. 19, 1918	0 01½
First National Copper Co.	Copper	600,000	5 00	----------	630,000	Feb. 25, 1919	0 15
New Idria	Quicksilver	100,000	5 00	----------	2,705,000	Jan. 1, 1919	0 25
North Star	Gold	250,000	10 00	----------	5,100,000	Dec. 31, 1920	0 30
Oroville Dredging	Gold	686,538	£1	----------	£429,036	Sept. --, 1920	9 d.
Plymouth Con.	Gold	240,000	£1	----------	£156,000	Mar. --, 1920	12d.
U. S. S. R. & M., U. S. (also Mexico)	Lead, Zinc, Copper, Silver, Gold	351,115 486,350	$50 00 50 00	175,557 ----------	$15,315,779 24,881,268	Jan. --, 1921 Oct. 10, 1920	0 50 0 87½
Yukon Gold (also Alaska and Nevada)	Gold	3,500,000	5 00	----------	9,858,110	June --, 1918	0 02½

[1]Common. [2]Preferred.
*Mining and Scientific Press, Vol 123, p. 243, Aug. 13, 1921.

Current Prices of Ores and Minerals.[1]

"The following prices represent approximately what can be obtained for the products indicated, delivered at points on San Francisco Bay. These, of course, vary widely with the grade and purity of the ores. The present stagnant condition of the market makes many of the quotations purely nominal; most of the ores can be purchased at these prices, but it should be understood that it is not easy for the producer to market them at this time. This list is corrected monthly by Atkins, Kroll & Co.

Antimony ore, approximately free of lead and arsenic, not less than 50% Sb, per %	60¢
Asbestos (crysotile) according to length of fibre, per ton	$20 to $2,500
Barite, white and free of iron (crude), per ton	$5 to $10
Bismuth ore, not less than 20% Bi, per % Bi	$12
Feldspar, crude, lump, free of iron, per ton	$5 to $10
Fluorspar, 85% calcium fluoride, per ton	$15 to $20
Fuller's earth, ground to pass 80-mesh, per ton	$5 to $10
Graphite, crystalline, per pound	3¢ to 7¢
Magnesite, calcined, per ton	$25 to $35
Manganese ore, less than 0.75% Fe; less than 6% SiO_2, per ton	$25 to $30
Mica, according to size, clearness, and cleavage, per pound	$1 to $8
Molybdenite, not less than 85%, free of copper, per % MoS_2	$8 to $12
Ochre, according to strength, crude, per ton	$8 to $15
Sulphur, 99.5% pure, only trace of As and Se, per ton	$15 to $18
Talc, lump, white, per ton	$7.50 to $10
Tin ore, not less than 60% Sn, per % Sn	$5
Tungsten ore, not less than 65% WO_3 per % WO_3	$2.75 to $3"

New Import Tariff Schedule.

The Fordney Tariff Bill introduced in the House, June 29, 1921, contains the following provisions relating to ores and minerals, as summarized by the Mining and Scientific Press:[2]

"Barytes, crude $4 per ton; ground $7.50 per ton; precipitated barium sulphate or blanc fixe, 1¢ per pound; lithopone and other combinations or mixtures of zinc sulphate and barium sulphate, 1½¢ per pound.

[1]Mining and Scientific Press, June 4, 1921, p. 798.
[2]Mining and Scientific Press, July 9, 1921, p. 67.

"Manganese ore and concentrates in excess of 30% metallic manganese 1¢ per pound of metallic manganese content; ferro-manganese 2½¢ per pound of metallic manganese content.

"Molybdenum ore or concentrates 75¢ per pound on the metallic molybdenum contained. Ferro-molybdenum, all molybdenum compounds and alloys, $1.25 per pound of molybdenum contained plus 17% ad valorem.

"Tungsten ore or concentrates 45¢ per pound on metallic tungsten contained. Ferro-tungsten, tungsten powdered, all other compounds of tungsten, 72¢ per pound on tungsten contained plus 15% ad valorem.

"Bauxite $1 per ton; aluminum 5¢ per pound; in plates, sheets, bars, etc. 9¢ per pound.

"Magnesium $1 per pound; magnesium alloys and manufactures $1 per pound on magnesium content plus 20% ad valorem.

"Quicksilver 7¢ per pound (later amended to 35¢ per pound).

"Nickel in pigs 5¢ per pound; manufactured 30% ad valorem.

"Tin in bars or pigs, scrap or granulated, 2¢ per pound.

"Lead ores and mattes 1¼¢ per pound on lead contained, with a proviso for the admission of 2000 tons of lead contained in copper matte free of duty each year; lead bullion, antimonial lead, scrap-lead, type-metal, babbit, solder or alloys or combinations of lead, 2½¢ per pound of lead contained; lead in sheets, pipe, shot, etc., 2⅜¢ per pound; lead acetate, white, 3½¢ per pound; brown, gray, or yellow, 2½¢ per pound; nitrate 2½¢ per pound; arsenate and resinate, 30% ad valorem; litharge, orange mineral, red and white lead 2¾¢ per pound; pigments containing lead 30% ad valorem.

"Zinc-bearing ore, including calamine under 10% zinc, free; over 10 and less than 20% zinc, ½¢ per pound of zinc contained; over 20 and less than 25% zinc, 1¢ per pound of zinc contained; over 25% zinc, 1½¢ per pound on zinc contained for the next two years. Zinc in blocks, pigs, slabs, old and worn out zinc, 2¢ per pound; in sheets, plates, strips, fabricated or zinc dust, 2¾¢ per pound. Thereafter duties shall be as follows: Over 10 and less than 20% zinc, ¾¢ per pound of zinc contained; over 20 and less than 25% zinc, ½¢ per pound on zinc contained; over 25% zinc, 1¢ per pound on zinc contained. Zinc in blocks or pigs and zinc dust, 1⅜¢ per pound; in sheets, 1⅝¢; in sheets plated, 1⅞¢; old and worn out zinc, 1¢.

"Graphite 10% ad valorem.

"Fluorspar $5 per ton for one year; thereafter, $4 per ton.

"Kaolin $2.50 per ton.

"Antimony 1½¢ per pound.

"Mica 6¢ per pound plus 17% ad valorem, unmanufactured 12¢ per pound and 17%. Ground mica, 6¢ per pound and 20% ad valorem.

"Potash, for two years 2½¢ per pound on potassium oxide contained; one year thereafter 2¢ per pound; one year thereafter 1½¢ per pound; one year thereafter 1¢ per pound; after five years, free.

"Petroleum, crude, 35¢ per barrel of 42 gallons; fuel oil 25¢ per barrel. (Eliminated by vote of the House.)

"Magnesite, crude or ground, ½¢ per pound; dead-burned and grained ¾¢ per pound."

The bill has passed the House with the figures above shown, with the exception of the two changes indicated in parentheses following quicksilver and petroleum.

CHAPTER TWO.

FUELS.

Among the most important mineral products of California are its fuels. This subdivision includes coal, natural gas and petroleum, the combined values of which make up over 50% of the state's entire mineral output.

There are deposits of peat known in several localities in California, small amounts of which are used as a fertilizer; but none has as yet been utilized for fuel.

Comparison of values during 1919 and 1920 is shown in the following table:

	1919		1920		Increase + Decrease − Value
	Amount	Value	Amount	Value	
Coal	2,983 tons	$8,203	2,078 tons	$5,450	$2,753−
Natural gas	52,173,503 M. cu. ft.	4,041,217	58,567,772 M. cu. ft.	3,898,286	142,931−
Petroleum	101,182,962 barrels	142,610,563	103,377,361 barrels	178,394,937	35,784,374+
Total value		$146,659,983		$182,298,673	
Net increase					$35,638,690+

COAL.

Bibliography: State Mineralogist Reports VII, XII, XIII, XIV, XV. U. S. G. S., Bulletins 285, 316, 431, 471, 581; An. Rep. 22, Pt. III.

Coal has been produced in California since as early as 1860, and until the development of crude oil was an important factor in the mineral industry of the state. As most of it is lignite, the quality is generally poor as compared with other coals on the Pacific Coast markets. However, in competition with fuel oil, coal of all grades has had to take second place. Within recent months, however, owing to the high prices of petroleum products, there have been some inquiries for coal deposits in California. Besides the counties noted below as showing a commercial production, workable bodies of coal are also known in several others, including Alameda, Contra Costa, Mendocino, Shasta, and Siskiyou. Some coal has also been produced, in the past, in Fresno and Orange counties.

During 1920 production was reported from Amador, Monterey and Riverside counties totaling 2078 tons, worth $5,450. That from the Ione mine in Amador County and the Alberbill mine in Riverside County was utilized for steaming and domestic purposes, locally. That

produced at the Stone Cañon property, Monterey County, was consumed at the mine in keeping the mine open and the pumps operating, none being shipped out during 1919 nor 1920. This property has recently (June, 1921) been sold to Eastern parties, who are preparing to reopen the mine and resume shipments.

Tests have been made by the U. S. Geological Survey[1] on some of the Ione lignite (because of its resemblance to some oil shales), to determine if it will yield oil on destructive distillation. Up to 62 gallons of oil per ton was obtained and also 18 pounds of ammonium sulphate as a by-product. The latter is valuable as a fertilizer. Analyses showed: 16% fixed carbon, 31% volatile matter, 46% moisture, 7% ash; and the heating value is 6,060 British thermal units.

The very considerable output of coal in the years previous to 1883 was almost entirely from the Mount Diablo district, Contra Costa County. Later, the Tesla mine in Corral Hollow, Alameda County, was an important producer for a few years. The following tabulation gives the annual tonnages and values, according to available records:

Coal Output and Value by Years.

Year	Tons	Value	Year	Tons	Value
1861	6,620	$38,065	1892	85,178	$269,711
1862	23,400	134,550	1893	72,603	167,555
1863	43,200	248,400	1894	59,887	139,862
1864	50,700	291,525	1895	79,858	193,790
1865	60,530	348,048	1896	70,649	161,335
1866	84,020	483,115	1897	87,449	196,255
1867	124,690	716,968	1898	143,045	337,475
1868	143,676	826,137	1899	160,941	420,109
1869	157,234	904,096	1900	176,956	535,531
1870	141,890	815,868	1901	150,724	401,772
1871	152,493	876,835	1902	88,460	248,622
1872	190,859	1,097,439	1903	93,026	265,383
1873	186,611	1,073,013	1904	79,062	376,494
1874	215,352	1,238,274	1905	46,500	144,500
1875	166,638	958,169	1906	24,850	61,600
1876	128,049	736,282	1907	23,734	55,849
1877	107,789	619,787	1908	18,496	55,503
1878	134,237	771,863	1909	49,389	216,913
1879	147,879	850,304	1910	11,033	23,484
1880	236,950	1,362,463	1911	11,047	18,297
1881	140,000	805,000	1912	14,484	39,092
1882	112,592	647,404	1913	25,198	85,809
1883	76,162	380,810	1914	11,859	28,806
1884	77,485	309,950	1915	10,299	26,662
1885	71,615	286,460	1916	4,037	7,030
1886	100,000	300,000	1917	3,527	7,691
1887	50,000	150,000	1918	6,343	16,149
1888	95,000	380,000	1919	2,983	8,203
1889	121,280	288,232	1920	2,078	5,450
1890	110,711	283,019			
1891	93,301	264,902	Totals	5,164,658	$22,881,910

The tonnages in the above table for the years 1861-1886 (incl.) are taken from the U. S. Geological Survey, "Mineral Resources of the U. S., 1910," p. 107. The values assigned for the years previous to 1883 are those given by W. A. Goodyear (Mineral Res., 1882, pp. 93-94), being an average of $5.75 per ton. From 1887 to date the figures are those of the California State Mining Bureau.

[1]U. S. Geol. Surv., Press Bulletin No. 402, March, 1919.

NATURAL GAS.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 3, 16, 19, 69, 73. Monthly Summary, Oil & Gas Supervisor, Dec. 1919.

Statistics on the production of natural gas in California are in a considerable degree difficult to arrive at, as much of it that is utilized directly at the wells for heating, lighting, and driving gas engines is not measured. Hence, it is necessary to approximate the output of many of the operators in the oil fields.

The figures here given are certainly not over estimated, particularly in the six oil-producing counties. It must be remembered that several of our important oil fields are removed many miles from the site of any other industry, and that the gathering of small amounts of gas and transporting it for any considerable distance may not always be profitable. However, it is undoubtedly a fact that greater saving can frequently be made with profit. Gas traps of various size and design are in use. Some large operators are making commendable efforts to conserve the gas which accompanies oil and is richer than the so-called 'dry gas' occurring in strata which do not produce oil. Wherever feasible, casing-head gas is used in driving gas engines for pumping and drilling, and in firing the boilers of steam-driven plants.

The most notable, new, gas development in California in recent years has been by the Standard Oil Company in the Elk Hills field in Kern County, northeast of the Midway district. Construction work has been started this spring (1921) by the San Joaquin Light and Power Company on a large power unit at Buttonwillow, for the utilization of the Elk Hills natural gas to produce electric power. Heavy gas pressures have also been encountered by the American Oil Fields Company in prospect wells (June, 1921) in the Buttonwillow district which is northeast of Elk Hills. Among the very recent activities, the Pacific Gas and Electric Company is inaugurating a program of prospecting for natural gas in the hope of developing a commercial supply in the Montezuma Hills in Solano County. A small amount of gas has been obtained in the past from this district which is within piping distance of San Francisco.

Several counties produce gas which is not accompanied by oil, particularly Sacramento and San Joaquin, where it is mixed with manufactured gas for domestic service. The Tulare Lake district in Kings and Tulare counties also does not yield oil.

There is rather a wide variation in prices quoted for natural gas because such a large proportion is used directly in the field for driving gas engines and firing boilers, and is therefore not measured nor sold.

Such companies as have attempted to place a valuation on the gas that was thus used in 1920 gave from 3¢-15¢ per 1000 cubic feet. From the totals shown in the tabulation following herein, the average value for 1920 works out at approximately 6.7¢. Approximately 7000 cubic feet of gas is equal to one barrel of oil in heating value, and is so accounted for by many operators. In driving gas engines, about 4000 cu. ft. per 24 hr. are consumed by a 25 h.p. engine, and 63,700 cu. ft. per day for heating a 70 h.p. steam boiler, which figures have been used in compiling this report.

NATURAL GAS, 1920.

County	M. cubic feet	Value
Fresno	3,721,313	$201,865
Kern	34,912,865	1,810,147
Kings	2,765	1,250
Los Angeles	6,225,835	556,465
Orange	10,520,483	862,446
San Joaquin	200,433	74,957
Santa Barbara	1,359,665	128,126
Tulare	400	195
Ventura	1,521,448	214,280
Butte, Humboldt, Lake, Mendocino, Sacramento, Solano, Sutter and Yuba*	102,565	48,555
Totals	58,567,772	$3,898,286

*Combined to conceal output of an individual producer in each.

Natural Gas Production in California, Since 1888.

The production of natural gas in California by years since 1888 is given in the following table. The first economic use of natural gas in California was from the famous Court House well at Stockton, bored in 1854-1858. Beginning about 1883 and for several succeeding years, a number of gas wells were brought in around Stockton. Natural gas was known in a number of other localities, and occasionally utilized in a small way, notably at Kelseyville in Lake County, and in Humboldt County near Petrolia and Eureka, but there are no available authentic records of amounts or values previous to the year 1888. The most important developments in the commercial production of natural gas have been coincident with developments in the oil fields, by utilizing the casing-head gas as well as that from dry-gas wells.

Year	M. cubic feet	Value	Year	M. cubic feet	Value
1888	a12,000	$10,000	1906	168,175	$109,489
1889	a14,500	12,680	1907	169,991	114,759
1890	a41,250	33,000	1908	812,883	474,581
1891	a39,000	20,000	1909	1,148,467	616,932
1892	a75,000	55,000	1910	10,579,933	1,676,367
1893	a81,600	68,500	1911	a5,600,000	491,859
1894	a,b85,680	79 072	1912	a12,600,000	940,076
1895	a,b110,800	112,000	1913	14,210,836	1,053,292
1896	a,b131,100	111,457	1914	16,529,963	1,019,470
1897	a71,300	62,657	1915	21,992,892	1,706,480
1898	a111,165	74,424	1916	28,134,365	2,871,751
1899	115,110	95,000	1917	44,343,020	2,964,922
1900	40,566	34,578	1918	46,373,652	3,289,524
1901	120,860	92,031	1919	52,173,503	4,041,217
1902	120,968	99,443	1920	58,567,772	3,898,286
1903	120,131	75,237			
1904	144,437	91,035	Totals	314,420,407	$26,537,604
1905	148,315	102,479			

a—Quantity, in part, estimated, where values only were reported.
b—Includes natural CO_2 from a mine in Santa Clara County.

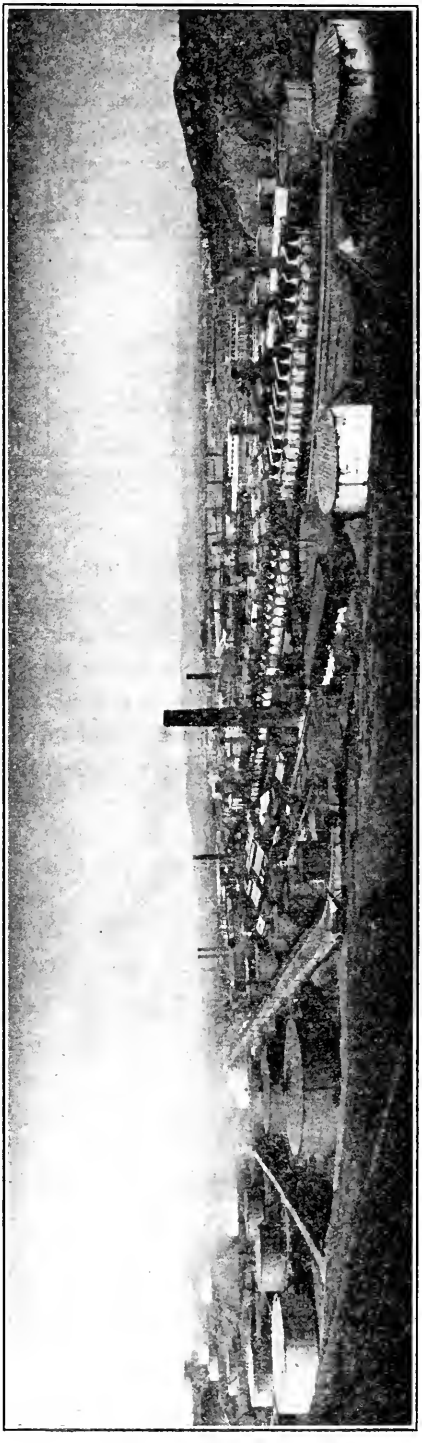
Gasoline from Natural Gas.

More or less gas usually accompanies the petroleum in the oil fields. More than 50 plants are in operation manufacturing gasoline by compression or absorption from this 'casing-head gas.' After the gasoline is extracted, the remaining 'dry gas' is taken into the pipe lines, by which it is distributed to consumers, both domestic and commercial.

In the Midway field, some of the casing-head gasoline is obtained as an incidental product to the compressing of the natural gas preliminary to transmission through the gas pipe lines. Some concerns market casing-head gasoline separately, while others turn it into the oil pipe lines, thus mixing this high-gravity gasoline with the crude oil for transportation to the refinery, where it is later regained. A total of 54,817,467 gallons of casing-head gasoline from all fields was reported by 39 companies, as made during 1920 and utilized directly as such. This compares with 38,034,256 gallons by 29 companies in 1919. It was distributed by counties, as follows:

County	Gallons gasoline
Fresno	317,503
Kern	31,799,201
Los Angeles	1,689,026
Orange	10,633,308
Santa Barbara	9,324,872
Ventura	1,103,554
Total	54,817,467

The usual recoveries of gasoline from natural gas vary from ½ gal. to 3 gal. per 1000 cu. ft. of gas handled, the average being about 1 gal. per 1000 cu. ft.



Richmond Refinery of the Standard Oil Company, at Point Richmond, Contra Costa County.

The largest natural gas field of commercial importance thus far developed in California is in the Midway district, Kern County, followed by Orange, Los Angeles, Fresno, Santa Barbara and Ventura counties. The Midway Gas Company operates a 12-inch pipe line from the Midway field, a distance of 107 miles, to Los Angeles, where it supplies gas to local distributing companies. The Valley Natural Gas Company supplies gas to consumers in the Midway field and to local distributing companies at Fellows, Taft, Maricopa, Bakersfield, and the Kern River fields. The Santa Maria Gas and Power Company distributes gas around Santa Maria, from wells in the neighboring oil fields.

PETROLEUM.

Bibliography: State Mineralogist Reports IV, VII, X, XII, XIII. Bulletins 3, 11, 16, 19, 31, 32, 63, 69, 73, 82, 84, 89 (in press).

Chief of the fuels of California is petroleum. A complete description of the industry is to be found in Bulletin 69, issued in 1915 by the State Mining Bureau; supplemented by Bulletins 73, 82 and 84, annual reports of the Oil and Gas Supervisor, 1915–1918, and by the 'Summary of Operations,' issued monthly since April, 1919. The state law providing for the regulation of drilling and maintenance of oil and gas wells by the State Mining Bureau has been in effect since 1915. The chief aim is to protect the oil deposits from damage by water, and to aid producers in their work. A staff of technically trained men maintain offices in the various fields.

The oil production for California for 1920, as shown by the sworn statements made to the State Mineralogist for the Department of Petroleum and Gas, by the producers from 9,642 wells (except part of the Los Angeles City field) amounted to 103,184,734 barrels net. 'Net' means that a deduction of approximately 2% has been made for water. The oil consumed for fuel at the wells is also included. This shows an increase of 2,111,217 barrels from the similar net figures of 1919.

To the above amount, we have here added 192,627 barrels, being the output of various small operators in the Los Angeles City field, not included in the reports to the Oil and Gas Supervisor, making a total for the year 1920 of 103,377,361 barrels, valued at $178,394,937. Compared with 1919, this is an increase of 2,194,399 barrels in quantity, and of $35,784,374 in value. This great advance in value is due to the continued increase in the average price per barrel for all fields and grades which began in 1916, as will be seen in Table B, *post*. The total or average figures on price per barrel at the well are difficult to obtain, as it must be remembered that a large portion of the crude oil

does not enter the open market, but is consumed or refined directly by the producers. The prices given are for oil which is actually sold, and are known to be accurate.

Features of 1920.

The outstanding feature of California oil production is its fairly constant rate for several years past. Such a condition may be expected to continue for several years and any shortage of oil or its products will be due to an increased consumption. Kern, Orange and Ventura were the only counties showing marked increase in production for 1920 over 1919. The Kern County yield increased by 2,926,403 barrels, or over 6%. This was due mainly to the new Elk Hills field, and to increased drilling in the Midway district. Orange County increased 1,004,019 barrels, or nearly 7%, due to the new Huntington Beach field, but which, however, did not quite regain the level of that county's 1918 output. Ventura County increased 304,508 barrels, or 18%. Los Angeles County decreased nearly 1,000,000 barrels, Fresno 700,000 barrels, and Santa Barbara over 200,000 barrels.

As interesting evidence of what can be accomplished under pressure by a large organization with resources of men and materials at its command, the following experience of the Standard Oil Company in the Elk Hills is quoted:[1]

"When Tupman No. 1 came in on February 12, there was nothing in this barren area except the one rig—no storage facilities nor pipe-lines. The well began to flow 4500 barrels daily, the oil flowing into temporary sumps speedily built by a force of 150 men which was gathered. Two 500-barrel tanks were brought in from Taft, nineteen miles away by road. The pipe-line from Taft to Bakersfield fortunately was only two and a half miles from the well. Within forty-eight hours after the well had come in, the two storage-tanks had been set up, two and a half miles of pipe-line laid and pumps installed, so that the oil was moving from the well to the refinery within forty-eight hours. Tupman No. 1 having demonstrated the presence of oil, work, aside from the drilling of oil-wells, was begun, to make possible the intensive development of the field. The construction work dealt with roads, compressor plants, machine shops, an electric-light plant, a telephone system leading to the near-by lines between Taft and Bakersfield. A gas main to a line leading from the Midway field to Bakersfield was also laid. A small town has sprung up on the Tupman property, consisting of the usual oil-camp buildings. Three hundred men are now at work on the property, and in the cook house more than nine hundred meals are served every day. Plans are being made for the building of a recreation hall. There are seventy-five horses and mules and five tractors on the property. Fifteen miles of roads have been graded and oiled."

The Elk Hills field is still the center of important development operations. There were at least ten companies drilling there or preparing to do so, by March, 1921. Wells that flow from 2000 to 5000 bbl. per day, each, are a powerful stimulant to the rapid development of lands adjoining such wells. Development, which usually spreads rapidly in all directions from the discovery well, is partly restrained at the east end of Elk Hills because the structure from which wells are producing lies partly within Naval Petroleum Reserve No. 1. In April,

[1]Standard Oil Bulletin, Dec. 1920, P. 3.

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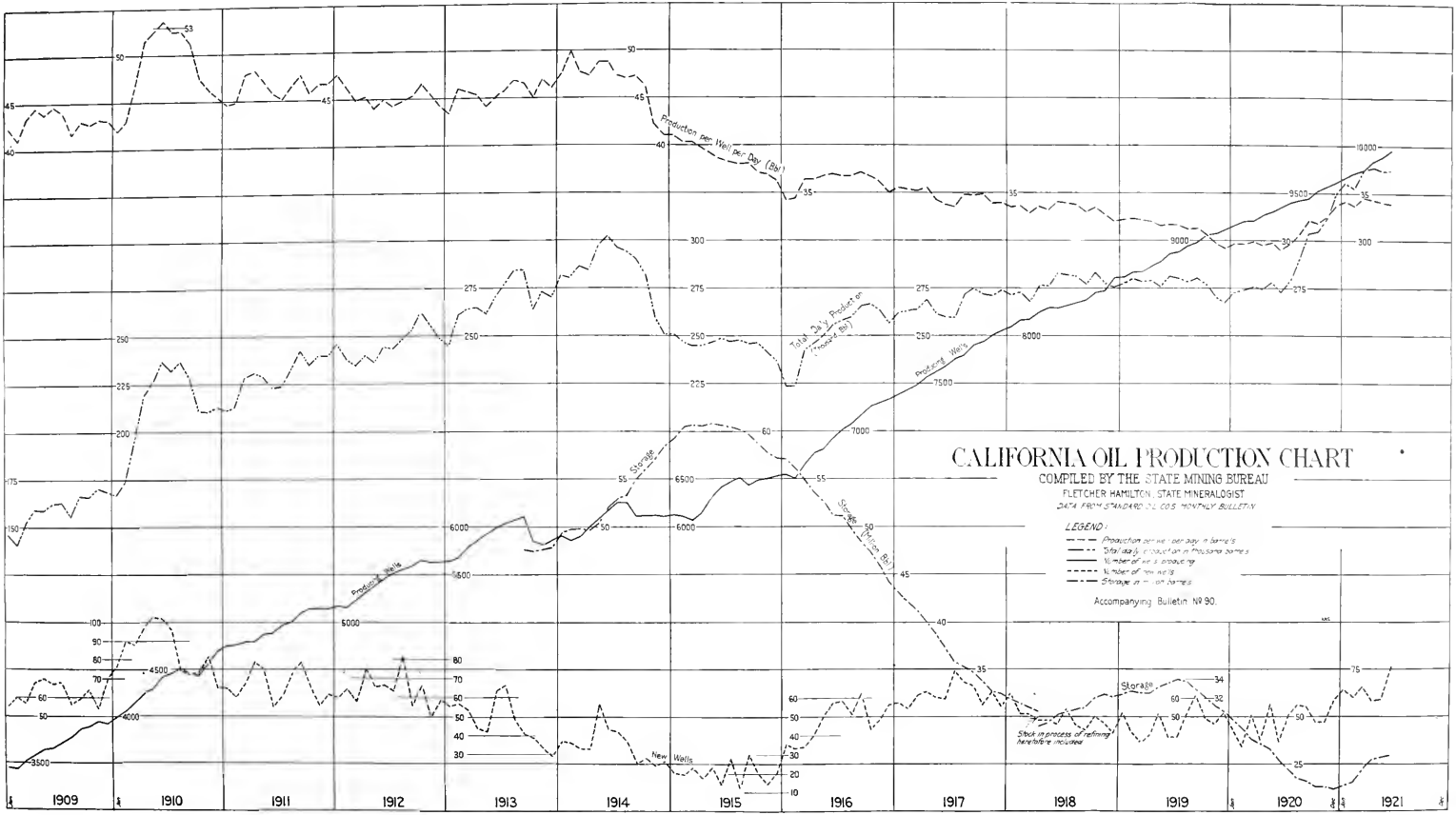
CALIFORNIA OIL PRODUCTION CHART
COMPILED BY THE STATE MINING BUREAU
FLETCHER HAMILTON, STATE MINERALOGIST
DATA FROM STANDARD OIL CO'S MONTHLY BULLETIN
LEGEND:
Production per well per day, in barrels
Total daily production in thousand barrels
Number of wells producing
Number of new wells
Storage in million barrels
Accompanying Bulletin № 90.
Production per Well per Day (Bbl.)
Total daily Production (Thousand Bbl.)
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Storage
Storage (Million Bbl.)
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1921, a total of 50,000 bbl. of oil per day was being produced from 25 wells, mostly in Secs. 35 and 36, T. 30 S., R. 24 E., M. D. M. That almost equaled the production of the 1900 wells in the Coalinga, Lost Hills, and Belridge fields combined. The Elk Hills wells in that month were averaging 2400 bbl. per day each. A similar production from 20 additional wells would exert a critical influence on the oil business of the state.

Three factors of the moment, which may cause a less acute demand for California petroleum than that of 1920, are: the relief of the hydro-electric power situation by abundant snowfall last winter and continued later than usual, with a concurrent release of petroleum products for substitute power; the big drop in the price of eastern and mid-continent crudes, leaving a price balance favorable to the importation of petroleum products from other states; and an almost complete shut-down of western copper furnaces, which use large quantities of California fuel oil.

At Huntington Beach, the Orange County field, which joined the producing list in 1920, town-lot drilling has forced a race, among offsetting wells, to be first into the producing sand. In some cases the speed of drilling is adjusted to the rapidity of the sale of oil stocks. The feverish haste of stock-selling concerns to get oil threatens the life and security of the Huntington Beach field. The State Oil and Gas Supervisor[1] has issued the following statement which should be thoughtfully studied by all who have invested, or contemplate doing so:

"During the week eight new wells were reported ready to drill in the Huntington Beach oil field. There are 65 or more wells in progress of drilling. In spite of the great drilling activity during the eleven months since the first well was drilled into production, only 18 wells are producing. There is no partly developed field in the state where the drilling of successful producers is attended with greater uncertainties as to relative positions of water and oil sands. The situation is further complicated by the growing congestion of drill holes on town lot holdings. There are a number of these holes which could not reasonably be expected to yield a profit over the costs of development even if properly drilled. To the investment hazard, because of inadequate acreage per well, must be added the inevitable damage to oil wells and the oil field itself which comes from congested drilling. Experienced oil operators are having great difficulty in properly excluding unexpected water sands in this field in order to get producing wells. The managers of concerns whose principal energies are directed toward the realization of quick returns from the sale of stock cannot indefinitely circumvent these conditions of fact. The Huntington Beach oil pool existed long before town lots were laid out, and there is no worthy reason why this pool should be made the theatre of stock speculation instead of normal oil field development.

"Experience of normal development in California shows that an oil well, in order to be a going concern, should have an allotment of at least five acres from which it can draw oil with a minimum amount of interference. Oil wells are normally operated for profit, and it is fair to assume that, if greater profit could be made by drilling wells closer together than is now the practice in developed fields, they would be so drilled.

"In Huntington Beach oil field it requires anywhere from 10 to 75 town lots, dependent upon their size, to make the equivalent of the minimum five acres a normal oil well needs. Many holdings fall short of this minimum area. Considering the cost of drilling, high operating costs, and the depths of wells, it is probable that five acres is not sufficient for economic operation. In order to yield a profit to the investor, these small tracts must first return the costs of financing, advertising, exorbitant salaries, and commissions on sales of stocks, in addition to the ordinary costs of development and production.

"The average cost of drilling to production at Huntington Beach is over $65,000 per well. Depending upon depth to oil, difficulties incident to shutting off water and sand troubles, drilling costs alone vary from $10,000 to $90,000 per well. The output

[1]Collom, R. E., Weekly press bulletin, No. 296, June 25, 1921.

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"The average cost of drilling to production at Huntington Beach is over $65,000 per well. Depending upon depth to oil, difficulties incident to shutting off water and sand troubles, drilling costs alone vary from $40,000 to $90,000 per well. The output

[1]Collom, R. E., Weekly press bulletin, No. 296, June 25, 1921.

of present producers under flush conditions ranges from 30 to 2000 barrels per day. Eighteen wells are now producing at a daily rate of less than 400 barrels per well. Only one well is producing over 1000 barrels per day. The production comes from depths varying from 2300 to 3700 feet.

"There is nothing phenomenal about the geologic nature of the productive possibilities of Huntington Beach oil fields. If given a fair chance, it will make a good oil field. At present the estimated probabilities of productive area are liberally indicated as 1500 acres and it will ultimately take its place with the smaller oil fields of the state providing, after the stock-jobbing orgy is over, it is recognizable as an oil field."

There is a natural decrease in production from all oil wells as time passes after their completion. The average daily production from California wells decreases about two barrels each year. In order to maintain a given total output, new wells must be continually drilled. The area of proved oil land increased in 1920 about 3% with a total of 94,567 acres.

The use of electricity as a motive power is increasing in the oil fields, superseding both casing-head gas and crude-oil fuel. It is proving economical in cost, not only of operation, but also of installation and maintenance; and permits of increased oil production from the wells, owing to steadier and more continuous operation.

Production Figures.

The following table gives the production by counties for 1920, compared with the 1919 figures:

TABLE A.

Production and Value of Oil, by Counties.

County	1919		1920	
	Barrels	Value	Barrels	Value
Fresno	16,091,037	$20,805,711	15,375,454	$22,801,798
Kern	47,734,035	64,440,947	50,660,438	86,831,991
Los Angeles	15,076,633	20,805,751	14,026,536	21,488,653
Orange	14,458,722	26,893,223	15,462,741	33,059,340
San Luis Obispo	31,656	32,922	42,511	59,515
San Mateo			322	966
Santa Barbara	6,089,082	6,850,217	5,803,583	9,140,643
Santa Clara	16,724	26,695	16,095	23,901
Ventura	1,685,073	2,755,094	1,989,681	4,988,130
Totals	101,182,962	$142,610,563	*103,377,361	$178,394,937

*See p. 25, *ante*.

TABLE B.

Average Price of Oil per Barrel, by Counties.

County	1914	1915	1916	1917	1918	1919	1920
Fresno	$0.452	$0.545	$0.516	$0.825	$1.191	$1.293	$1.483
Kern	.409	.423	.641	.893	1.252	1.350	1.714
Los Angeles	.550	.629	.651	1.176	1.340	1.380	1.532
Orange	.675	.512	.663	1.003	1.412	1.860	2.138
San Luis Obispo			.450	.926	.905	1.010	1.400
Santa Barbara	.460	.611	.794	.808	1.235	1.125	1.575
Santa Clara	.530	.666	.666	1.387	1.700	1.600	1.485
Ventura	1.050	.855	1.045	1.318	1.480	1.635	2.507
State average	$0.461	$0.479	$0.636	$0.908	$1.278	$1.409	$1.726

The low price in Santa Barbara County for 1919 and 1920 is due to a large production of 8° to 10° gravity oil from the Casmalia field, which brought only about 50¢ per barrel in 1919 and 39¢ in 1920. For several years previous to 1919, the average value per barrel at the well for crude oil as determined by the statistical returns was noted to practically coincide with the quotations during the same years for 23° gravity oil. In 1919, the average value for all grades worked out at a figure corresponding to the quotations for 28° oil, due to the fact that the increased output of that year was mainly from the Montebello field in Los Angeles County which yielded high-gravity oil. The 1920 figure of $1.726 corresponds approximately to the average of quotations for 24°-25° oil for the year.

TOTAL PETROLEUM PRODUCTION OF CALIFORNIA.

The presence of oil seepages and springs in Los Angeles and Ventura counties was known and even utilized in a small way early in the history of California. According to Hanks,[1] in 1874 production amounted to 36 bbl. per day from natural flows in Pico Cañon (Newhall), and at Sulphur Mountain (Ventura County), the oil being of 32° gravity average.

[2]"Work was commenced in Pico Cañon in 1875, by drilling three shallow wells with spring pole, all of which yielded oil at depths of from 90 to 250 feet. Actual work of development commenced with steam machinery in 1877."

In 1877, Pico averaged 40-50 bbl. daily, and Ventura, 80 bbl. daily. In 1878, there was some production (@ 60 bbl. per day, for a time) from wells in Moody Gulch, near Los Gatos, Santa Clara County, the oil being of 46° Baumé.

The first wells in the Coalinga, Fresno County, and Summerland, Santa Barbara County, fields were drilled in 1890, but Coalinga did not make its influence felt conspicuously on the state's annual output until 1903. The Summerland yield never has been large. The Salt Lake field near Los Angeles began production in 1894 and in 1897 reached over a million barrels annually.

In the Kern County fields, the first well was drilled in Sunset in 1891, Midway in 1900, McKittrick in 1892, Kern River in 1899. The Sunset-Midway district attained a yield of over 4,000,000 bbl. in 1909, and over 20,000,000 bbl. in 1910. Kern River field produced over 3,000,000 bbl. in 1901.

[1]Hanks, Henry G., Report IV of State Mineralogist, p. 298, 1884.
[2]*Idem*, p. 301.

The first well in the Santa Maria-Lompoc group, Santa Barbara County, was drilled in 1901, and the district advanced to a yield of over 3,000,000 bbl. annually in 1905.

The Whittier-Fullerton field in Los Angeles and Orange counties became an important factor in 1902. The Montebello field, Los Angeles County, was the conspicuous addition in 1919, and Elk Hills, Kern County, and Huntington Beach, Orange County, in 1920.

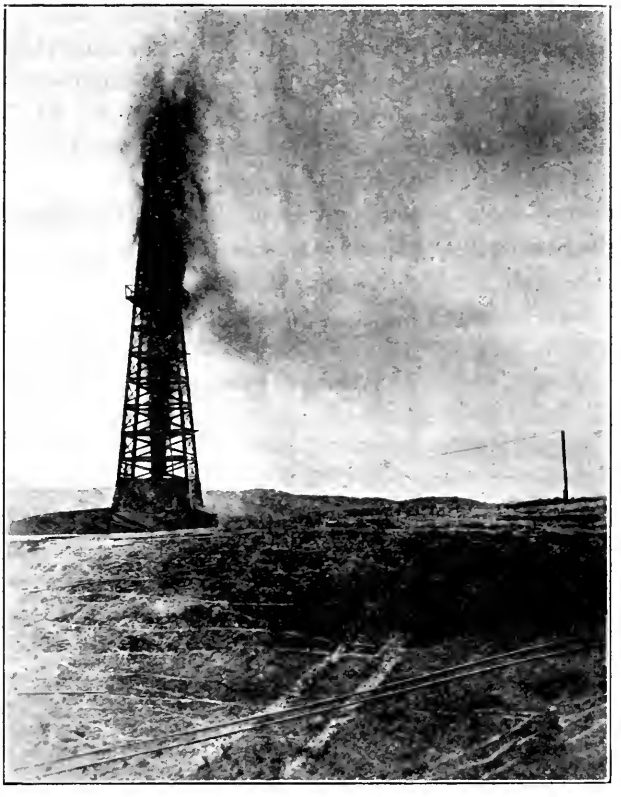
The effect of the advent of these various fields to the producing column will be noted in the tabulation herewith, by years:

TABLE C.

Total Petroleum Production in California.

Year	Barrels	Value	Year	Barrels	Value
To and inc. 1875	(a)175,000	(b)$472,500	1899	2,677,875	$2,660,793
1876	12,000	30,000	1900	4,329,950	4,152,928
1877	13,000	29,250	1901	7,710,315	2,961,102
1878	15,227	30,454	1902	14,356,910	4,692,189
1879	19,858	39,716	1903	24,340,839	7,313,271
1880	40,552	60,828	1904	29,736,003	8,317,809
1881	99,862	124,828	1905	34,275,701	9,607,820
1882	128,636	257,272	1906	32,624,000	9,238,020
1883	142,857	285,714	1907	40,311,171	16,783,943
1884	262,000	655,000	1908	48,306,910	26,566,181
1885	325,000	750,750	1909	58,191,723	32,398,187
1886	(a)377,145	(b)870,205	1910	77,697,568	37,689,542
1887	678,572	1,357,144	1911	84,648,157	40,552,088
1888	690,333	1,380,666	1912	89,689,250	41,868,344
1889	303,220	368,048	1913	98,494,532	48,578,014
1890	307,360	384,200	1914	102,881,907	47,487,109
1891	323,600	401,264	1915	91,146,620	43,503,837
1892	385,049	561,333	1916	90,262,557	57,421,334
1893	470,179	608,092	1917	95,396,309	86,976,209
1894	783,078	1,064,521	1918	99,731,177	127,459,221
1895	1,245,339	1,000,235	1919	101,182,962	142,610,563
1896	1,257,780	1,180,793	1920	103,377,361	178,394,937
1897	1,911,569	1,918,269			
1898	2,249,088	2,376,420	Totals	1,343,586,101	$992,840,949

(a) U. S. G. S., Min. Res. of U. S., 1886, p. 440, for quantities to and including 1886.
(b) Values have been estimated for the years to and including 1886, after consulting a number of contemporaneous publications, including the Mining & Scientific Press, Reports of the State Mineralogist, and U. S. Reports. The figures for 1887 to date are from records of the State Mining Bureau.



Well flowing over 10,000 barrels of oil per day. Elk Hills, Kern County, California.

The following table shows the distribution, by fields, of the 1920 output, compared with 1919, as given by the Standard Oil Company:

TABLE D.

Production by Fields.*

(In barrels of 42 gallons.)

Field	1919	1920
Kern River	7,563,025	7,456,515
McKittrick	2,810,848	2,607,240
Midway-Sunset	32,003,952	37,917,010
Lost Hills-Belridge	4,554,821	4,139,767
Coalinga	16,385,610	15,464,198
Lompoc and Santa Maria	6,030,910	5,928,060
Ventura County and Newhall	1,792,465	2,122,449
Los Angeles and Salt Lake	1,341,415	1,311,264
Whittier-Fullerton	28,657,683	28,694,163
Summerland	53,680	54,910
Watsonville and miscellaneous	27,375	25,610
Totals	101,221,784	105,721,186
Net increase		4,499,402

*Standard Oil Bulletin, January, 1921.

The figures of the Independent Producers Agency show 101,907,729 bbl. for 1919, and 105,618,706 bbl. for 1920. The reason that the State Mining Bureau's totals are less than those of the Standard and Agency is due to the fact that a deduction of approximately 2% has been made for water content in the oil as pumped and as reported from pipe-line runs.

The following table is compiled from the monthly statements contained in the Standard Oil Bulletin:

TABLE E.

Well Operations, by Fields, 1920.

	Producing Dec., 1919	Producing Dec., 1920	Completed during year	Abandoned during year	Bbl. per well produced per day, Dec., 1920
Kern River	2,067	2,152	93	4	9.3
McKittrick	341	352	8	9	19.3
Midway-Sunset	2,348	2,509	197	16	55.4
Lost Hills-Belridge	561	591	27	6	18.7
Coalinga	1,229	1,293	66	20	31.7
Santa Maria-Lompoe	378	406	28	5	39.7
Ventura and Newhall	504	513	28	6	11.8
Los Angeles and Salt Lake	665	666	2	----------	5.4
Whittier-Fullerton	887	990	123	8	82.1
Summerland	142	140	----------	----------	1.14
Watsonville	5	9	----------	----------	7.2
Totals	9,127	9,621	572	74	*33.8

*State average.

The proportion of heavy and light oil produced in the various fields is shown by the following figures, for which we are indebted to the Standard Oil Company. Oil below 18° Baumé may be considered as largely unrefinable, or fuel oil, while the lighter oils yield varying amounts of refined products and a very large proportion of residuum and fuel oil. A few years ago, the total amount of heavy oil was in excess of the light oil.

TABLE F.

Production of Light and Heavy Oil, by Fields, 1920.

Field	Under 18° (barrels)	18° and over (barrels)	Total (barrels)
Kern River	7,456,515	----------	7,456,515
McKittrick	2,607,240	----------	2,607,240
Midway-Sunset	9,780,449	28,136,561	37,917,010
Lost Hills-Belridge	1,245,625	2,894,142	4,139,767
Coalinga	5,613,158	9,851,040	15,464,198
Santa Maria-Lompoe	3,024,550	2,903,510	5,928,060
Ventura County and Newhall	83,045	2,039,404	2,122,449
Los Angeles and Salt Lake	1,160,920	150,344	1,311,264
Whittier-Fullerton	1,233,610	27,460,553	28,694,163
Summerland	54,910	----------	54,910
Watsonville	----------	25,610	25,610
Totals	32,260,022	73,461,164	105,721,186

In addition to consuming the current production of crude oil, the storage was drawn upon at an average rate of 22,514 barrels per day during 1920. According to the Standard Oil Company,* the stocks on hand December 31, 1920, amounted to 22,240,271 barrels, a decrease of 8,240,052 barrels from the 30,480,323 barrels on hand December 31, 1919.

Federal Trade Commission Report.

The Federal Trade Commission, following an investigation ordered by the United States Senate under the 'Poindexter Resolution' of July 28, 1919, has recently (April 7, 1921) issued Part I of its report on the 'Pacific Coast Petroleum Industry.' This part deals with production, ownership, and profits. Part II, which is in course of preparation, will discuss prices, marketing methods, and competitive conditions.

The portion of the report already issued contains much of interest and importance to California; for which reason we here quote it somewhat at length:

"The outstanding facts regarding the Pacific Coast Petroleum Industry shown in this part of the report may be concisely stated as follows:

"(1) Owing to the scarcity and high prices of coal, petroleum products, especially fuel oil and gasoline, are probably of more importance to industry and commerce on the Pacific coast than in any other large section of the country.

"(2) California, however, is one of the largest petroleum producing states; its output has rapidly increased, and there are no present indications of a decline in the near future.

"(3) Recently, i. e., from June, 1915, to January, 1921, demand has exceeded supply, with a consequent steady reduction of stocks, but since the beginning of this year production has exceeded consumption and stocks have increased slightly.

"(4) The oil land 'withdrawals' ordered by the Government in 1909, for the purpose of reserving a supply for the Navy and in order to suspend the patenting of oil lands until the public land laws could be revised, did not prevent overproduction down to June, 1915, but from then until 1920, had probably a somewhat retarding influence on the development of new production.

"(5) All branches of the pretroleum industry on the Pacific coast, i. e., crude petroleum production, pipe-line transportation, and refining and marketing, are dominated by a few large interests which control most of the proven oil lands and operate nearly all the pipe-line and refining equipment.

"(6) The costs of producing crude petroleum vary widely between different fields and between different companies in the same field. The chief factor in cost seems to be the volume of production per well. The large companies as a group have the more productive wells and show the lowest average costs.

"(7) There was a great increase in the cost of production of crude petroleum between 1914 and 1919 for all classes of companies; there was also a marked increase in the cost of transportation by pipe line and in the cost of refining.

"(8) The profits of the crude petroleum industry of California were comparatively low in 1914 and 1915, but they were unusually large in 1918 and 1919. This increase in the average rate of earnings resulted from a great advance in crude petroleum prices. While the average rates of earnings from the crude petroleum business in the later years were large, the fact that there was a scarcity of crude, resulting from a steady growth in demand, appears to afford an adequate economic explanation of the increase in prices and earnings.

"(9) With respect to gasoline, kerosene, fuel oil, and other products of crude petroleum, the factors affecting prices were more complex and conclusions as to their reasonableness are reserved to the second part of this report, which deals particularly with such prices.

"(10) The earnings of the five large integrated companies, namely, the Standard Oil Co. (California), the Union Oil Co. of California, the Associated Oil Co., the Shell Co. of California, and the General Petroleum Corporation, which are engaged in crude petroleum production, pipe-line transportation, refining, and marketing of gasoline, fuel oil, and other petroleum products, and which are the dominating factors in this industry on the Pacific coast, were generally low in 1914 and 1915, but they all show either very good or very high rates of earnings in 1918 and the first half of 1919.

"(11) Data regarding the results of the petroleum industry for the whole country for the entire year 1919 indicate that the situation as to profits in the California

*Standard Oil Bulletin, January, 1921.

petroleum industry was not exceptional compared with other sections of the United States in that year.

"(12) While the petroleum shortage of 1919 and the first part of 1920 seems to have been temporarily met, both on the Pacific coast and in the United States as a whole, the problem of an adequate petroleum supply for the future does not appear to be fully solved and the Commission reiterates certain recommendations which it made in a report to the House of Representatives on June 1, 1920, namely, (a) that the active support of the Government be given to those engaged in the oil industry to develop production in foreign countries; (b) that methods of drilling for petroleum and the utilization of petroleum products and their substitutes should be a subject of special study in technological and economic aspects with a view to conserving the supply; (c) that the great importance of information regarding changes in industrial and commercial conditions in the oil trade suggests the need of making provision for having such information currently collected and reported for the use of Congress, the public, and the industry.

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"PRODUCTION OF CRUDE PETROLEUM.

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"California has produced a larger aggregate quantity of crude petroleum than any other single State, and during recent years it has ranked either first or second in the quantity of its annual production. In 1920 it produced 105,721,000 barrels, which is its largest annual production up to the present time, and constituted 23.8 per cent of the total output of the United States. There was an overproduction of crude petroleum in California from 1910 to the middle of 1915 and large quantities were placed in storage. Beginning in 1915 and continuing through 1920 the annual cosumption of California crude petroleum has exceeded its annual production. Even with the record of 105,721,000 barrels in 1920, consumption exceeded production by about 8,240,000 barrels. At the present time, 1921, due to the discovery of new oil pools and the resumption of development of 'withdrawn' lands, production has been increased to such an extent that, should the present rates of production and consumption be maintained, the 1921 output will again exceed consumption.

"California crude petroleum generally contains a much smaller gasoline content than that produced in other oil fields of this country, and a considerable percentage of the crude petroleum is sold directly for fuel purposes. In recent years, however, the proportion of lighter gravity crude petroleum, which contains a higher gasoline content, has increased, namely, from 45 per cent in 1910 to 69 per cent in 1914, since which time its proportion has fluctuated from 65 to 68 per cent. This increase makes it possible to obtain a larger percentage of gasoline, but it lessens the proportion of fuel oil. An adequate supply of petroleum is more important for the Pacific coast than for any other section of the country, as it constitutes the main or only source of fuel for heating purposes, marine and river navigation, public utilities, railways, and for mining and manufacturing industries. Even its dependence upon gasoline and other motor fuels is greater than in any other section for use by the agricultural and horticultural industries. California supplies most of the industries of Arizona, California, Nevada, Oregon and Washington with fuel and refined products. The absence of an adequate supply and the relatively high price of coal make fuel oil a very important factor in the entire Pacific coast region.

"CONTROL OF THE INDUSTRY.

"Every branch of the petroleum industry, from the ownership of oil lands to the distribution of refined products, is controlled by a few large interests. In the ownership of oil lands and the production of crude petroleum there are seven large interests, namely, the Union Oil Co. of California, the Associated Oil Co.-Southern Pacific interests, the Standard Oil Co. (California), the Shell Co. of California, the General Petroleum Corporation, the Doheny companies, and the Santa Fe Railway.

"The seven large interests named above, owned 68 per cent of the proven oil lands in California on March 1, 1920, while in 1919, according to the California State Mining Bureau, there were 345 different concerns engaged in the business of producing crude petroleum. In that same year, these seven interests produced practically 71.5 per cent of all the crude petroleum production of the State. Three of these, namely, the Associated Oil Co.-Southern Pacific interests, the Standard Oil Co. (California), and the Union Oil Co. of California, owned 51.5 per cent of the proven oil lands, and produced 52 per cent of the State's total production; while these three interests, together with the Shell Co. of California and the General Petroleum Corporation, own 58.5 per cent of the proven oil lands and produced 62 per cent of the 1919 production.

"Five large companies, viz: the Standard Oil Co. (California), the Union Oil Co. of California, the Associated Oil Co., the Shell Co. of California, and the General Petroleum Corporation, are the only important factors in the transportation of crude petroleum by pipe line and tank steamers, in petroleum refining, and in the distribution and marketing of petroleum products in the Pacific coast territory. These large interests own and operate practically all of the trunk pipe lines in California. Prior to 1914 the pipe-line capacity was at times not sufficient to transport the current production, but from 1914 to 1920 the carrying capacity of the pipe lines has greatly exceeded the current production. These same interests own almost 94 per cent of the fixed investment in petroleum refineries, 89 per cent of the rated daily refining capacity, and in 1919 refined 91 per cent of all the crude petroleum consumed by refineries in California.

"COST OF CRUDE PETROLEUM.

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"There is a very wide range in the costs for individual companies. In 1914 the lowest cost per barrel was $0.031, and the highest sixty-three times as great, or $1.96; while in 1918, the last complete year for which costs are shown, the range was from $0.14 per barrel to $5.36. Neither the very low nor the excessively high costs are representative. The lowest cost in 1914 was due to a very large production from flowing wells, while the abnormally high cost in 1918 was the result of a small production for that year for a company having a very large investment, which resulted in a very high cost per barrel for depletion. Some of the companies showing very low costs in one year had relatively high costs in other years, and the same is true for companies having very high costs. While in 1918 the cost of producing crude petroleum for individual companies ranged from $0.14 to $5.36 per barrel, 55 per cent of the total production covered by the report was produced by 20 companies at a cost not exceeding $0.42 per barrel, slightly more than 89 per cent was produced by 40 companies at a cost of not more than $0.568 per barrel, and the cost of only 3 per cent of this production, representing the output of 41 small companies, exceeded $1 per barrel. For different fields there are wide differences in the average costs.

"EARNINGS FROM PETROLEUM PRODUCTION.

"The crude petroleum industry is consequently one of very variable returns. In each year from 1914 to 1918 there were many companies whose costs were in excess of the prices at which they sold their crude petroleum. Thus, out of the 96 companies reporting in 1914 there were 47 companies which lost money, and out of the 134 companies reporting in 1918 there were 28 companies which showed a loss. In each case, however, the production affected was comparatively small; thus 17.9 per cent in 1914 and 1.6 per cent in 1918 of the total quantity reported was produced at a loss. The very speculative character of crude-petroleum production for companies beginning operations or for companies without a large established production is made clear by the detailed figures given in the report.

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"PIPE-LINE TRANSPORTATION.

"Five large interests, viz: the Standard Oil Co. (California), the Associated Oil Co., the Union Oil Co. of California, the General Petroleum Corporation, and the Shell Co. of California either own directly or through subsidiaries practically all of the trunk pipe-line mileage of the State of California. The combined mileage of their trunk pipe lines aggregate about 2450 miles and with a gross investment of almost $50,000,000. Their rated daily capacity is about 380,000 barrels, which is sufficient to transport 138,700,000 barrels annually, or 33,000,000 in excess of the 1920 production for the State.

"The cost of constructing trunk pipe lines is greater in California than in other sections of the country. For example, an 8-inch pipe line built in California in 1915 cost about $18,800 per mile, while the same size of line in the Mid-Continent field would have cost about $10,250.[1]

"This higher cost of construction is partly due to the fact that it is necessary to equip the pipe lines in California with heating facilities, which are used to raise the temperature of the crude to about 150° in order to facilitate its flow through the lines, and partly to the necessity of placing the trunk pipe-line pumping stations about 15 miles apart as compared with approximately 40 miles in the Mid-Continent field.

"The costs of transporting crude petroleum by pipe line, according to information furnished by the companies, increased for most companies. The costs for shipment from the San Joaquin Valley fields to San Francisco Bay points increased from $0.142 per barrel in 1914 to $0.213 for the first half of 1919 for one company, while another company shows an increase from $0.115 to $0.221 for the same years; this represents an increase of about 50 per cent for one company and almost 100 per cent for the other.

"All of the pipe lines from the California oil fields are intrastate lines, hence they were not made common carriers by the Hepburn Act placing interstate pipe lines under the jurisdiction of the Interstate Commerce Commission. However, the State of California in 1913 enacted legislation declaring pipe lines common carriers. Some of the pipe-line companies voluntarily filed tariffs with the State Railway Commission. While two companies contested the jurisdiction of the State Railway Commission, one was judicially held to be a common carrier and the other a private carrier and not subject to the jurisdiction of the railway commission.

"The pipe-line rates that have been named by the companies filing tariffs originally conformed closely to the railroad rates and disregarded entirely the cost of the service plus a reasonable return on the investment in the pipe-line properties. Rates from the different San Joaquin Valley fields to San Francisco Bay points are now 35 cents per barrel for distances ranging from about 200 to 300 miles, while the rates for short distances, for example, about 30 miles, range from 8 to 10 cents per barrel. Since the pipe-line companies have not transported crude petroleum as common carriers, except in the case of a subsidiary, which has transported only for the parent company, the rates have been of interest only to the different departments of the five large companies.

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[1] Federal Trade Commission, Report on Pipe Line Transportation of Petroleum, pp. 55 and 59.

"COST OF REFINING.

"Five companies, viz: the Standard Oil Co. (California), the Union Oil Co. of California, the Associated Oil Co., the Shell Co. of California, and the General Petroleum Corporation, at the end of 1919 owned and operated 15 refineries representing a gross investment of $47,000,000, out of a total for the State of $50,000,000. These refineries had in 1919 a rated daily capacity of almost 275,000 barrels out of a total of about 308,000 barrels and refined 66,445,000 barrels of the State's total of 72,618,000 barrels. In other words, these five companies owned 94 per cent of the gross investment in refineries, operated 89 per cent of the rated daily refining capacity, and in 1919 consumed 91 per cent of the crude petroleum refined.

"As already stated, California crude petroleum yields a smaller percentage of gasoline and naphtha than is generally secured from the crude petroleum produced in other fields, but in recent years the percentage obtained has increased considerably. From 1916–1920 the proportion obtained has increased from 11.7 to 15.4 per cent. This increase was partly due to the larger percentage of light refinable crude petroleum produced in California, which increased from 65 per cent in 1916 to about 70 per cent in 1920, and partly to the efforts of the large refiners to increase the gasoline and naphtha yields through the use of the Burton Process and other improved methods of refining. The effect of both of these factors has been somewhat obscured, however, by the practice of refining heavier crudes than formerly; these heavier crudes yield a very small proportion of gasoline and naphtha.

"The cost of refining crude petroleum is shown in detail for the five companies named above for the period 1916–June 30, 1919, and for two of the companies from 1914 to the latter date. The cost of refining a barrel of crude petroleum, including the cost of the crude, for all companies combined increased from $0.738 per barrel in 1916 to $1.259 for the first half of 1919; this represents an increase of 71 per cent. The crude petroleum costs are taken at the actual cost of production, if produced, or at purchase price, if bought. There was a wide range in the costs for individual companies. In 1916 the lowest cost for a particular company was $0.602 and the highest $0.845, which represents a difference of $0.243, or 40 per cent, while in 1919 the lowest cost was $0.95 and the highest $1.631, which gives a difference of $0.681, or 71.7 per cent. The companies showing high costs are those purchasing a large proportion of the crude petroleum they refine.

"The principal element of cost for a barrel of refined petroleum products is the raw material—crude petroleum—even when the crude is charged to the refinery at its cost of production plus transportation cost. On this basis the raw material represented 79.4 per cent of the total cost in 1914 and about 74 per cent in 1919. The refinery operating expense was about 13.5 per cent in 1914 and 17.7 per cent in 1919, while the general and administrative and depreciation combined were 7.1 per cent in 1914 and 8.3 per cent in 1919. The refining labor cost is a very small factor in the cost of a barrel of refined petroleum products, and during the period covered it varied from only $0.012 in 1914 to $0.046 in 1919.

"The advantages possessed by the large integrated companies over companies engaged in refining only is made apparent by a comparison of the combined integrated costs shown for the five large companies, i. e., crude charged to their refineries at actual producing and pipe-line transportation cost, with costs computed on the basis of crude petroleum at the current market prices in the oil fields, plus transportation charges at published tariff rates. For all companies for which costs are shown their cost of refining a barrel of crude petroleum would have been $0.24 per barrel, or 32 per cent higher in 1914, had they not owned crude petroleum production and pipe lines; while in 1919 it would have been $0.69 per barrel, or 55 per cent greater. Hence, it is evident that it is practically impossible for a refiner without low-cost petroleum production and pipe lines, unless the refinery is near the oil field, to become an important factor in the petroleum industry in California.

"EARNINGS OF LARGE COMPANIES.

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"The Commission's revision shows that the rates of earnings for the five large integrated companies from the petroleum business were generally low in 1914 and 1915 or that some of them incurred losses, while beginning with 1916 there was generally a rapid increase until in 1918 and the first half of 1919 the rates of profit for each company were quite large.

"The question of the reasonableness of prices for the various petroleum products will be discussed fully in Part II. However, in an industry such as the petroleum business, which produces a large number of different products, the reasonableness of prices can only be satisfactorily answered after the profits of the business have been ascertained. The price of a particular product, such as gasoline, may be advanced and appear unreasonably high, without increasing the margin obtained by the refiner, if other products decline in price or costs increase without corresponding increases in the price of other products. As already pointed out, by far the most important element in the cost of a barrel of refined petroleum is the cost of the raw material—crude petroleum. During the period 1914–June 30, 1919, the price of crude petroleum in California advanced greatly, and at the present time, April, 1921, crude petroleum prices are still at the highest level ever attained. The rates of earnings for crude petroleum producing companies show clearly that the prices were not remunerative for a substantial proportion of the production in 1914 and 1915. In 1918 and 1919, however, such prices were advanced until this branch of the business, so far as reported to the Commission, except for a small percentage of the production, was very profitable and the earnings increased from $0.17 to $0.79 per barrel. Apparently during the last half of 1919 and in 1920 this branch of the industry was also very profitable. Supply and demand conditions were such that high prices of crude petroleum appear to have been logical in order to stimulate to the utmost the production of crude petroleum.

"EARNINGS FOR ENTIRE INDUSTRY.

"For comparison with the foregoing data for the Pacific coast territory the following facts regarding the petroleum industry for the United States are of interest. This information was reported by the companies and was not checked with their records by representatives of the Commission, as was the case for the large companies already discussed. It was secured only for the year 1919 in connection with another inquiry in response to House resolution 501, Sixty-sixth Congress, second session, and was furnished by the companies in schedules prepared by the Commission. Fairly complete data were furnished for 82 producing companies and 138 refining companies.

"A total production of 239,038,000 barrels of crude petroleum, or 63.3 per cent of the total production of 377,719,000 barrels for the United States, as reported by the United States Geological Survey, was covered by these reports. Of this total reported, 224,190,000 barrels, or 59.4 per cent of the total production of the United States, was produced by 32 large companies and their subsidiaries, each of which produced over 1,000,000 barrels. These 32 companies, however, represent only 20 different interests; 9 companies are members of the Standard Oil group and the remaining 23 large independents. The 9 Standard companies produced 21.3 per cent of the total production of the United States in 1919, while the 23 large independents produced 38.1 per cent of the total. Most of these companies also refined crude oil or were closely affiliated with refining companies.

"The Crude-petroleum producing companies of the Standard Oil group produced 8.5 per cent of the total, while Standard companies which are also engaged in refining produced 12.8 per cent. The independent producing companies produced 6.7 per cent of the total, while the independent companies which also refined produced 31.4 per cent. For both Standard and independents the production was 15.2 per cent for producing companies and 44.2 per cent for those which also refined.

"Companies belonging to the Standard Oil group owned 36.5 per cent of the total rated refining capacity of the United States in 1919, as reported by the Bureau of Mines, and they were operated at a higher percentage of their rated capacity than the independent refiners, as they refined 43.8 per cent of the total crude petroleum consumed by all refineries. The large independent refining companies reporting had a refining capacity of 43.3 per cent and consumed 41.1 per cent of the crude consumed.

"The proportion of gasoline and naphtha secured from the crude petroleum from the principal oil fields east of the Rocky Mountains during 1919 was much higher than that secured in California. Refineries operating only on Appalachian crude show a yield of gasoline and naphtha of 27.4 per cent, those refining Mid-Continent crude had a yield of 27.9 and those for Wyoming obtained a yield of 22.2, while California refiners secured only 13 per cent. Refineries equipped with pressure stills secured much higher yields of gasoline and naphtha, those refining Mid-Continent crude secured 46 per cent, while from Wyoming crude 41 per cent was obtained.

"The investments used to show the earnings from the petroleum business only include the capital stock, surplus, and funded debt, and exclude appreciation, the investments in affiliated and other companies, and also Government and other securities; while the earnings are those shown before the deduction of interest on funded debt or Federal taxes and exclude interest and dividends received.

"On this basis the 82 companies reporting, which produced 62,162,000 barrels, showing an investment in the crude-petroleum business of $365,847,000 and earnings of $64,728,000, or a return of 17.7 per cent. A further analysis of the return from the crude-petroleum business for these 82 companies by profit groups discloses the fact that 14 of them with a production of 2.6 per cent of the total reported and an investment of 3.6 per cent showed an average loss of 2.8 per cent, while earnings of over 30 per cent are shown for 14 companies having 37.3 per cent of the production with only 15.1 per cent of the total investment. The average rate of earnings for these latter companies was 41.2 per cent, while the total for all groups was 17.7 per cent.

"Of the 42 crude-petroleum companies operating in the Mid-Continent field, 6 companies with only seven-tenths of 1 per cent of the production and 1.3 per cent of the net investment showed a loss of 3.4 per cent. A profit of more than 30 per cent was shown by 8 companies with a production of 28 per cent of those reporting for this field but with an investment of only 4.8 per cent, the average rate of earnings for these 8 companies being 57.3 per cent. The average rate of earnings for the 42 companies reporting from the Mid-Continent field was 17.2 per cent, which is slightly lower than the average for all fields.

"There were 138 petroleum-refining companies which submitted satisfactory reports. These covered a total crude consumption of 303,321,000 barrels or nearly 84 per cent of the total consumption for the entire country, as shown by the Bureau of Mines. These companies or affiliated interests produced 116,221,000 barrels of crude petroleum or 38.3 per cent of their refinery consumption. On a total investment of $2,088,283,000 they made a profit of $349,819,000 or an average of 16.8 per cent. The highest average rate was 27.6 per cent for 7 companies in the Rocky Mountain region with an investment of $59,887,000.

"The average rate of earnings for these 138 companies on their investment in the domestic petroleum business alone averaged 20 per cent on an investment of $1,525,677,000 as against 16.8 per cent on their entire business. The refiners operating in the Rocky Mountain region on the same basis show an average rate of 32 per cent on an investment of $48,040,000. Twenty-eight refiners consuming 3 per cent of the crude and having 1.9 per cent of the investment show an average loss of 8.5 per cent. Thirty-nine refiners with 18.7 per cent of the total net investment in the petroleum business and consuming 16.2 per cent of the crude petroleum refined by the companies reporting earned less than 10 per cent, with earnings of 5.9 per cent. There were 28 companies that earned profits of 30 per cent or over. This group refined 22.5 per cent of the crude petroleum, owned 22.2 per cent of the net investment, and showed an average rate of earnings of 34.9 per cent.

"When these companies are grouped according to the magnitude of their investment in the domestic business, 5 companies with an investment of over $100,000,000 each, or a total of $722,023,000, showed an average rate of earnings of 24.6 per cent, while the lowest average rate of earnings is shown for the 31 companies with an investment of between $1,000,000 and $5,000,000. These companies have an aggregate net investment of $65,225,000 and show an average rate of earnings of 15.4 per cent. More than half of the 138 companies from which reports were obtained had an investment of less than $1,000,000 each. The aggregate net investment of these companies was $27,991,000, on which they earned an average of 17.3 per cent.

"Small refiners in the Mid-Continent field claimed that they were making very small profits during 1919, particularly during the last six months of the year. The reports submitted agree with their claim, as shown by the results for 28 refiners in Oklahoma, which reported average earnings of 6.3 per cent on the petroleum business for the entire year.

"During 1914 and the first half of 1915 there was an over production of crude petroleum for the entire country, and the prices for crude petroleum and refined products were very low. Profits in the producing branch of the industry for 1914 and 1915 east of the Rocky Mountains, as in California, were probably low. Beginning in the latter part of 1915 the prices of crude petroleum began to rise and were increased steadily, except for a decline for a few months in 1916, until they were stabilized by the industry in cooperation with the Fuel Administration in the spring of 1918. In the latter part of 1919 crude prices began to advance and the maximum general level was reached about the first of March, 1920. These maximum prices were maintained until January, 1921, from which time to April 1, 1921, they have been reduced about 50 per cent. It seems probable that the profits in the crude-petroleum industry generally increased from 1916, and that large profits were the rule in 1919 and 1920.

"Data collected by the Commission, some of which have been published, show that for refiners generally throughout the entire country 1914 was a year of low profits. The year 1915 was a much more profitable one for refiners east of the Rocky Mountains than for those operating in California, although as in California the industry was more prosperous from 1916 to 1918. The year 1919 was also generally prosperous for the petroleum industry of the whole country except for refiners in the Mid-Continent field."

Financial and Operating Conditions of California Oil Fields, 1920.

Financial results of the oil business during 1920 are shown by the following tables. The outstanding features are: (1) the continued substantial increase of prices for all grades over the 1919 figures; (2) a decrease in all of the fields except Ventura County, in the number of barrels per well per day yield; (3) an increase in operating costs per barrel, except in Los Angeles-Orange and Santa Barbara.

Operating cost per well is not always lower for the dividend companies than others. Profitable operations seem to depend generally upon large wells, high-grade oil, and proximity to market. There is nothing to indicate that unnatural causes or manipulation have affected the profits of one producer against another. It may be noted that both price and profits have usually been greater in the Los Angeles-Orange-Ventura fields than in others, doubtless largely due to the proximity to market and higher grades of oil. Crude oil testing as high as 56° Baumé is obtained from some of the Ventura wells.

In the tables following, data for Los Angeles and Orange counties are combined because of the Whittier-Fullerton field which covers an area extending over both sides of the county boundary line.

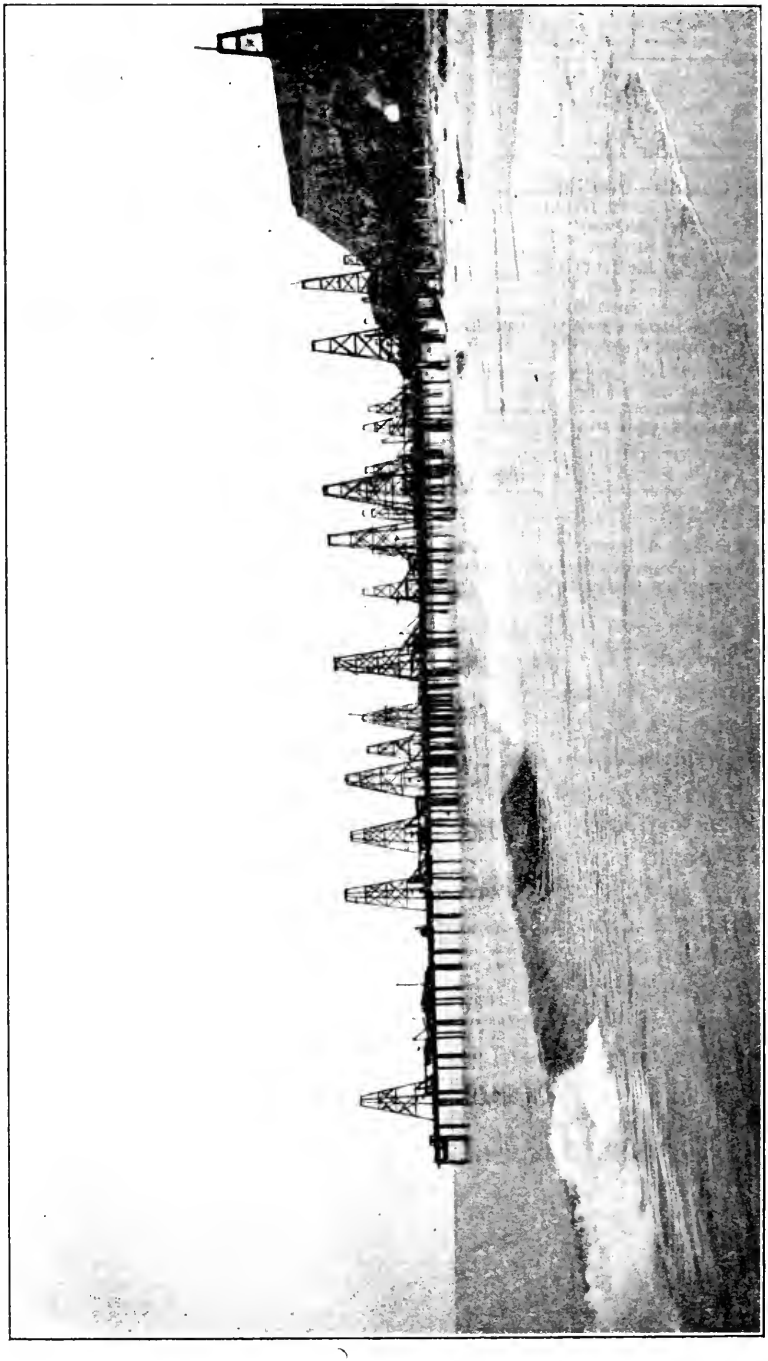
TABLE G.

Capitalization.

Field	No. of companies considered*	Per cent of total product of field	Capital	
			Cash	Property
Fresno County—Coalinga	50	23	$2,565,236	$27,552,881
Kern County—Kern River	46	27	3,178,372	7,211,257
Kern County—Midway	69	31	6,763,881	49,219,855
Kern County—Sunset	31		3,771,486	6,580,062
Kern County—McKittrick, Lost Hills, Belridge	23	43	1,461,946	11,712,402
Los Angeles and Orange counties	80	22	13,504,780	16,456,033
Santa Barbara County	17	28	1,512,566	9,332,825
Ventura County	19	72	982,964	7,554,118
Subtotals	335		$38,741,231	$135,619,433
Miscellaneous and marketing companies[1]	37	54	123,445,937	119,639,699
Totals	372		$162,187,168	$255,259,132

*See Table I, following.

[1]Includes companies having refineries, and those operating in several fields whose data could not be segregated as to counties or fields.



Summerland Oil Field in Santa Barbara County. Photograph by R. B. Moran.

Dividends Paid by Oil Companies, 1915-1920.

Field	1915		1916		1917		1918		1919		1920	
	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value
Coalinga	13	$283,660	12	$217,949	20	$712,331	23	$1,055,600	24	$1,352,969	29	$1,297,694
Kern River	20	187,962	23	405,556	22	306,508	31	609,293	27	1,235,877	26	783,625
Midway	23	853,376	29	1,207,974	34	1,938,769	42	3,015,862	32	8,360,447	39	7,096,819
Sunset and Maricopa	7	149,932	5	241,200	14	682,644	15	638,926	15	595,535	14	691,611
McKittrick, Belridge and Lost Hills	7	397,827	7	434,184	14	837,129	12	708,984	9	548,224	12	1,231,045
Santa Barbara County	6	317,727	7	293,025	6	923,228	5	286,768	5	355,490	7	312,332
Ventura County	2	120,143	5	126,812	3	71,637	2	4,400	4	120,584	5	559,942
Los Angeles and Orange counties	14	863,677	12	1,222,598	16	3,079,447	14	1,201,021	17	2,373,403	20	3,282,497
Subtotals	92	$3,174,304	100	$4,149,298	129	$8,551,693	144	$7,520,854	133	$14,942,529	152	$15,255,565
Miscellaneous and marketing companies[1]	13	9,926,044	13	*38,383,270	12	#40,981,214	11	19,984,138	26	20,476,322	9	31,072,321
Totals	105	$13,100,348	113	$42,532,568	141	$49,532,907	155	$27,504,992	159	$35,418,851	161	$46,327,886

*Includes a 50 per cent stock dividend of the Standard Oil Company. #Includes a 33⅓ per cent stock dividend of the Standard Oil Company.
[1]See Table G, preceding.

TABLE I.

Average Prices of Light and Heavy Oils, and Operating Data, 1920.

Field	Price				Operating data					
					All companies considered*			Dividend companies‡		
	Under 18° Baume	18° and over	Average price	Price to dividend companies	Barrels per well per day yield	Operating cost per well day	Operating cost per barrel	Barrels per well per day yield	Operating cost per well day	Operating cost per barrel
Coalinga	$1.447	$1.618	$1.483	$1.471	18.8	$8.44	$0.448	18.0	$8.26	$0.458
Kern River	1.435		1.435	1.435	8.7	3.90	0.451	8.5	3.84	0.391
Midway	1.552	2.008	1.806	1.847	24.9	10.83	0.435	30.3	11.93	0.394
Sunset and Maricopa	1.474	1.745	1.544	1.556	19.0	13.14	0.691	24.6	16.51	0.671
McKittrick, Lost Hills and Belridge	1.496	1.940	1.722	1.732	19.6	8.09	0.413	22.7	7.99	0.352
Los Angeles and Orange counties	1.238	2.050	1.916	1.710	26.0	13.10	0.504	27.0	16.96	0.628
Santa Barbara County	[a]0.787	2.249	1.575	1.731	28.8	15.38	0.534	20.7	9.46	0.457
Ventura County	1.315	2.514	2.507	3.021	22.3	20.16	0.904	11.4	8.12	0.712

*See Table G, preceding. Does not include companies with refineries, nor those operating in several fields whose data could not be segregated as to counties or fields.
‡See Table H, preceding.
It should be noted that in the case of a county like Ventura with only a few producers, the averages are not so significant as in other fields with a large number of operators. The figures of a single large operator in such a case can materially affect the general average if they should be much above or below the average of the others.
[a]This low price was due to a large production of 8°-10° gravity oil from the Casmalia field, which brought an average of under 50 cents per barrel.

Proved Oil Land.

The area of proved oil land increased about 3 per cent during 1920 to a total of 94,567 acres, with Kern, Orange and Ventura counties contributing mainly to the increase. Estimates of the total amount of oil which can be recovered from the land are little better than pure guesses but it does seem probable that the average acre will ultimately yield much less than fifty thousand barrels.

TABLE J.

"The following table[1] gives the production of oil and gas and proved acreage for 1920 by counties and also compares production of 1920 with that of twenty years ago.

County	Production oil—bbl.		Proved land (acres), 1920	Producing wells, 1920
	1900	1920		
Fresno	547,960	15,375,454	14,232	1,409
Kern	919,275	50,660,438	59,757	5,720
Los Angeles	1,722,887	14,026,536	2,959	1,120
Orange	254,397	15,462,741	4,666	617
Santa Barbara	183,486	5,803,583	9,223	503
Ventura	443,000	7,989,681	2,878	466
San Luis Obispo, Santa Clara, San Mateo	248,945	58,928	852	28
Totals	4,319,950	103,377,361	94,567	9,865

"In 1900, California contributed about one-fifteenth of the petroleum produced in the United States and about one-twenty-fifth of the world's production. In 1920, California produced almost one-fourth of the oil in the United States and one-fifth of the world output.

"Most of California's petroleum is produced in the six counties—Fresno, Kern, Santa Barbara, Ventura, Los Angeles and Orange. These have been the principal petroleum producing counties of the state for the past twenty years. All of the important discoveries of petroleum in California, from Kern River to Huntington Beach, have been in one of the six counties mentioned above.

"This does not mean, however, that there has not been a considerable effort to extend the limits of proved oil land. The March (1921) chapter of the Sixth Annual Report of the State Oil and Gas Supervisor, discusses prospect or wildcat operations in the state. It contains a list of all wildcat wells, numbering over 160, which have been started in the state since January 1, 1920.

"The year of 1920 was one of marked activity in wildcat operations. The activity and acreage involved is disproportionate to the actual additional 2775 acres proved. One hundred sixty wildcat wells were started either on privately owned or leased land. Conservatively this represented tests of at least 100,000 acres of privately owned land. One of these wells discovered oil in the east end of the Elk Hills, and another at Huntington Beach.

"Following the passage of the Federal land leasing act of February 25, 1920, some 200,000 acres of Government land have been filed upon by 200 or more permittees, under prospecting permits. Much of the land under prospecting permit is geologically unfit for the production of oil. A few wells are now being drilled. No discoveries have been made.

"In addition, applications have been made for Federal leases, and some leases granted, on about 24,000 acres in Fresno and Kern counties. Approximately 3000 acres are in Naval Petroleum Reserves No. 1 and No. 2. Of the area under applications for lease or leased, 3248 acres is classed by the State Oil and Gas Supervisor as proved oil land. This land represents holdings upon which producing wells were already drilled and for which applications for lease were made to the United States Government during the past year in lieu of claims for patent. The leases will permit the drilling of additional wells in present producing fields but will not open any new fields.

* * * * * * *

"The revised Map No. 15 of Elk Hills oil field shows the extent of drilling activity on private and Federal leased lands during the past year.

"Boundaries of Naval Petroleum Reserve No. 1 are also shown on the map. This Reserve covers an area of 38,000 acres and does not include the area at the east end of Elk Hills from which Pacific Oil Company, Standard Oil Company and Fan American Petroleum Company are now producing oil. The production from this

[1]Collom, R. E., State Oil and Gas Supervisor; Weekly Press Bulletin, No. 294, June 11, 1921.

Table Showing Operation of Proved Land (as Fixed by the Supervisor for Assessment Purposes March 1, 1920) and Number of Producing Wells Thereon June 30, 1920 (as Shown by Production Reports Filed by Operators).
Yearly production 1,000,000 barrels or over.

Field	Standard Oil			Southern Pacific Land Company			Associated and allied companies[1]			Union Oil			Shell Company			General Petroleum[7]			American Oilfields and allied companies[2]			Santa Fe Railroad and allied companies[4]			Pan-American Petroleum[5]			Commonwealth and allied companies[3]			Honolulu Consolidated			Interstate-Lakeview No. 2			Ventura Consolidated Oilfields[6]			All other companies			Totals		
	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well	Acres	Wells	Acres per well
Coalinga	840	152	5.3	3,760	168	22.4	1,501	129	11.6	260	28	9.3	2,673	286	10.0	234	21	11.1	1,165	99	11.8																			110	13	10.3	3,181	357	8.9	13,924	1,253	11.1
Kern River	612	157	3.3	437	233	1.9	2,656	575	4.6													399	185	2.3																3,120	952	3.3	7,034	2,042	3.4
McKittrick	130	9	14.4	180	51	3.5	662	122	5.4																20	0													588	133	4.4	1,380	317	4.98
Midway-Sunset	6,206	359	17.3	13,260	296	44.8	2,396	124	20.9	1,071	42	25.5				1,881	189	9.95	1,350	87	15.5	3,493	244	14.3	609	64	9.5	269	26	8.0	2,852	43	66.3	534	36	14.8							11,524	859	13.4	45,585	2,369	19.2
Belridge-Lost Hills	491	55	8.9				385	57	6.8	120	11	10.9				1,273	265	4.99	80	25	3.2							10	1	10.0										1,985	175	11.3	4,344	579	7.8
Salt Lake-Los Angeles							609	138	4.4										9	7	1.3																		396	121	3.3	1,014	266	3.8
Whittier-Fullerton	1,727	260	6.6				550	93	5.9	1,456	106	13.7				161	46	3.4	141	27	5.2	241	85	2.8				453	98	4.6										865	196	4.4	5,594	913	6.1
Ventura-Newhall	141	64	2.2							543	85	6.4	20	3	6.7	10	1	10.0							454	65	6.98										420	109	3.9	786	171	4.6	2,374	498	4.8
Santa Maria-Lompoc				157	0		1,302	43	30.3	5,734	198	28.96													933	53	17.6	1,099	56	19.6										1,038	49	22.6	10,263	396	25.9
Sargent																																								80	9	8.9	80	9	8.9
Totals	10,017	1,056	9.5	17,794	738	24.1	10,261	1,281	8.01	9,184	470	19.5	2,893	289	10.0	3,559	514	6.9	2,745	245	11.2	4,043	464	8.7	2,016	182	11.1	1,771	181	9.8	2,852	43	66.3	534	36	14.8	590	322	4.6	23,563	3,021	7.8	91,792	8,642	10.6
Per cent California proved land	10.91			19.38			11.18			10.01			3.15			3.88			2.99			4.40			2.20			1.93			3.11			.58			.61			25.67					

[1]Includes Amalgamated, West Coast, Casmalia Syndicate, Reward, Recruit, Pantheon, Pioneer Midway, Arcturus, Salt Lake and Coalinga Unity.
[2]Includes Petroleum Midway, Red Star, Niles Lease, California Star, American Petroleum and Midland Oilfields.
[3]Includes Western Union, United Western, Dunlop, Columbia and Eddystone.
[4]Includes C. C. M. O. and Petroleum Development.
[5]Includes E. L. Doheny and Doheny-Pacific Petroleum Company.
[6]Includes Oak Ridge, Homestead Development, Santa Paula, Consolidated Oil Lands and Montebello Oil.
[7]Includes National Pacific, Elliot, Bankline and J. M. S.

privately operated land is an indicator of the quantity of oil that may be expected from at least part of the Naval Reserve. In fact, the developments in Elk Hills of the past year have demonstrated the presence of a greater store of oil than was anticipated at the time the Reserve was created.

"Considering the probable total productive area of the Elk Hills, therefore, and regardless of the rather rapid decline of initial productions of oil wells in that area, the Elk Hills will continue to be a large factor in California oil production for some time to come."

Oil Land Ownership.

[1]"Control of California Oil Lands.

By R. P. McLaughlin.

* * * * * * *

"The accompanying tabulated statement shows the amount of land operated by each of the several companies whose annual production is in excess of one million barrels. No distinction is here made between operative lands which are owned in fee and those which are operated under lease. All lands designated by the State Oil and Gas Supervisor as proved oil lands on March 1, 1920, are included in the tabulation. The data are segregated according to the principal producing fields.

"The number of producing wells operated by each concern is also shown, together with the average amount of land per well. The number of wells is obtained from the monthly production reports for June, 1920, filed by operators with the State Oil and Gas Supervisor. Statistics of this sort can not be made absolutely accurate owing to the nature of the basic information. However, this summary is believed to represent conditions as closely as is possible. The detailed statistical work was performed by Miss R. A. Wagener.

"Development during the last six years has increased the acreage of proved oil land by about 26 per cent, from 72,535 acres to 91,792 acres. Such an increase should serve as a distinct warning to pessimistic forecasters who may incline to the belief that our oil resources are now fully explored. It is specially interesting to note that all the landholders have shared in the increase of proved land, and that monopoly does not exist. Five marketing companies hold 39 per cent of the total proved land and two railroad companies hold 24 per cent, leaving 37 per cent distributed among nearly three hundred smaller operators. Approximately the same ratios existed six years ago.

"The extent to which the various holdings have been developed is roughly indicated by the average amount of land per well. It has not yet been determined how closely wells can be economically drilled in California fields but there are some facts which indicate that about five acres per well is the probable average minimum. Therefore the present proved lands of the state may be expected to eventually support almost twice as many wells as have already been drilled.

"The present area per well is 10.6 acres as compared with 10.3 acres in the year 1914, which indicates that about the same margin of reserve or undeveloped land has been maintained.

"Undoubtedly, greater care must be exercised in the use of petroleum than has existed in the past and probably some branches of industry will have to turn to other sources of power. However, the foregoing facts show that final exhaustion of our oil resources is still considerably in the future."

The Water Problem in the Oil Districts.

[2]"Production Statistics of California Oil Fields.

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"The accompanying statement gives the data on production of oil and water from the various oil fields of the state for the six months prior to January 1, 1921. These data are compiled by the various field offices of the Department of Petroleum and Gas and are taken from monthly production reports submitted to the State Oil and Gas Supervisor.

"The total production of the state for the last six months of 1920 was 55,583,247 barrels of oil and 38,179,469 barrels of water, a total of 93,762,716 barrels of fluid.

"The Kern River field is the largest contributor to the water production of the state. The Department of Petroleum and Gas has already given considerable attention to water conditions in Kern River field. Recent investigations indicate that the Kern river is the source of a large quantity of the water production of the field.

"A considerable part of the operator's lifting costs in various fields is attributable to the water produced. Water causes higher production costs because of greater wear on pumping equipment. Much of the water is held in suspension or in the form of emulsion, after it leaves the lead line. The fluid must, therefore, be treated before it is accepted by the gathering stations of marketing companies. There is a wide variation in costs of treating. Oils containing only water in suspension can be treated by heating with steam coils or other simple devices. Emulsified oils are more refractory and can only be treated successfully by running them through special dehydration plants.

"There is no segregation made, in the statement of production, as between free water and water in the form of emulsion. The emulsion factor is a variable one,

[1]State Oil and Gas Supervisor, Sixth Annual Report, Monthly Chapter, October, 1920.
[2]State Oil and Gas Supervisor, Sixth Annual Report, Monthly Chapter, February, 1921, pp. 10-11.

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"The accompanying statement gives the data on production of oil and water from the various oil fields of the state for the six months prior to January 1, 1921. These data are compiled by the various field offices of the Department of Petroleum and Gas and are taken from monthly production reports submitted to the State Oil and Gas Supervisor.

"The total production of the state for the last six months of 1920 was 55,583,247 barrels of oil and 38,179,469 barrels of water, a total of 93,762,716 barrels of fluid.

"The Kern River field is the largest contributor to the water production of the state. The Department of Petroleum and Gas has already given considerable attention to water conditions in Kern River field. Recent investigations indicate that the Kern river is the source of a large quantity of the water production of the field.

"A considerable part of the operator's lifting costs in various fields is attributable to the water produced. Water causes higher production costs because of greater wear on pumping equipment. Much of the water is held in suspension or in the form of emulsion, after it leaves the lead line. The fluid must, therefore, be treated before it is accepted by the gathering stations of marketing companies. There is a wide variation in costs of treating. Oils containing only water in suspension can be treated by heating with steam coils or other simple devices. Emulsified oils are more refractory and can only be treated successfully by running them through special dehydration plants.

"There is no segregation made, in the statement of production, as between free water and water in the form of emulsion. The emulsion factor is a variable one,

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[1]State Oil and Gas Supervisor, Sixth Annual Report, Monthly Chapter, October, 1920.

[2]State Oil and Gas Supervisor, Sixth Annual Report, Monthly Chapter, February, 1921, pp. 10-11.

Field	Average number of producing wells	Oil (bbl.)	Water (including water in emulsion) (bbl.)	Total fluid (bbl.)	Number of days producing	Production per well per day				Percentage of time wells produced
						Barrels		Percentage		
						Oil	Water	Oil	Water	
District No. 1—										
Coyote Hills	219	4,165,616	945,552	5,111,168	37,344	111.5	25.3	81.5	18.5	92.7
Brea-Olinda	372	2,931,518	643,575	3,575,093	61,206	47.8	10.5	81.9	18.1	89.4
Puente	43	8,490	666	9,156	7,852	1.0	.08	92.7	7.3	99.2
Whittier	173	435,059	553,703	988,762	26,117	16.6	21.2	44.0	56.0	82.0
Montebello	133	5,358,190	416,629	5,774,819	21,790	245.9	19.1	92.8	7.2	89.0
Salt Lake	250	424,527	382,063	806,590	42,320	10.0	9.0	52.6	47.4	92.0
Newhall	77	50,999	137,023	188,022	11,508	4.4	1.2	27.1	72.9	81.2
Richfield	60	1,899,008	102,729	2,001,827	7,390	256.9	13.9	94.7	5.3	66.9
Huntington Beach	3	42,998	2,764	45,762	226	190.2	12.2	93.9	6.1	40.7
Beverly Hills	15	77,616	62,661	140,277	2,481	31.2	25.2	55.3	44.7	89.8
Santa Fe Springs	1	14,205	144	14,349	183	77.6	0.7	98.9	1.1	99.4
Totals	1,346	15,408,316	3,247,509	18,655,825	218,417	70.5	14.8	82.5	17.5	88.1
District No. 2—										
Simi	50	61,489	15,516	77,005	8,391	7.3	1.8	80.0	20.0	92.0
Piru	75	60,597	67,598	128,195	12,891	4.7	5.2	47.0	53.0	95.0
Bardsdale	134	241,341	26,419	267,760	23,720	10.1	1.1	90.0	10.0	97.0
Sespe	21	17,504	3,078	20,582	3,817	4.5	0.8	85.0	15.0	97.0
South Mountain	23	547,720	----------	547,720	3,680	148.8	----------	100.0	----------	88.0
Santa Paula	65	25,129	8,102	33,231	10,820	2.3	0.7	76.0	24.0	91.0
Ventura	18	75,341	223,532	298,873	3,050	24.6	73.2	25.0	75.0	94.0
Ojai	42	34,684	29,260	63,944	7,356	4.7	3.9	54.0	46.0	96.0
Conejo	1	536	53	589	60	8.9	0.9	91.0	9.0	37.0
Totals	429	1,064,341	373,558	1,437,899	73,785	14.4	5.0	74.0	26.0	94.0
District No. 3—										
Casmalia	87	813,189	2,269,671	3,082,860	15,086	53.9	150.0	26.0	74.0	95.0
Santa Maria	232	1,441,232	1,065,642	2,507,874	36,162	39.9	29.5	58.0	42.0	85.0
Cat Canyon	40	420,018	51,622	471,640	6,415	65.6	8.0	89.0	11.0	88.0
Lompoc	27	246,085	303,847	549,932	4,282	57.5	70.7	45.0	55.0	86.0
Arroyo Grande	17	19,971	9,019	28,990	2,229	8.9	4.0	69.0	31.0	68.0
Sargent	9	10,502	425	10,927	1,617	6.5	0.3	96.0	4.0	99.0
Half Moon Bay	2	168	----------	168	199	0.9	----------	100.0	----------	47.0
*Summerland	120	30,162	300,982	331,144	21,172	1.4	14.2	9.0	91.0	96.0
Totals	534	2,981,327	4,002,208	6,983,535	87,162	34.2	45.9	43.0	57.0	83.0
District No. 4—										
Midway-Sunset	2,429	15,226,322	7,859,210	23,085,532	413,524	33.8	19.0	66.0	34.0	92.5
Elk Hills	34	6,074,103	131	6,074,234	5,221	1,162.0	0.1	100.0	----------	83.5
McKittrick-Temblor	377	1,311,883	4,133,782	5,445,665	56,234	23.3	73.5	24.1	75.9	81.1
Lost Hills-Belridge	571	2,023,664	2,069,710	4,093,374	96,140	21.0	21.5	49.5	50.5	91.5
Kern River	2,067	3,583,152	14,346,447	17,929,599	358,790	10.0	40.0	20.0	80.0	94.3
Totals	5,478	28,219,124	28,409,280	56,628,404	929,909	30.4	30.6	49.8	50.2	92.2
District No. 5—										
Coalinga	1,288	7,910,139	2,146,914	10,057,053	216,111	36.62	9.93	78.65	21.35	91.18
Grand totals	9,075	55,583,247	38,179,469	93,762,716	1,525,384	36.3	25.02	59.3	40.7	

and the amounts are difficult to segregate. All emulsified oil is not formed in a manner beyond the operator's control. Roughly it may be considered that emulsion is formed by physical reactions between oil, gas and water, as (1) the fluids move through the sand and perforations in the oil-string, or (2) through improperly adjusted or worn-out working barrel assembly, or (3) by atomization, as the oil, gas and water mixture expands upon leaving the lead line.

"The second and third factors are controllable. Careful attention to pumping equipment and method of handling the oil, as it comes from the wells, will reduce treating charges. It should also raise the percentage of time a well produces. It is well known that water causes greater wear on pumping equipment and rods than oil. Interruptions of production are mostly chargeable to sand troubles, parted rods and worn pumping equipment.

"The percentage of time wells produced, shown in the last column of the table, is a good index to the relative difficulties attendant upon producing operations in the various fields."

Permanency of Oil Supply.

As to the ultimate yield of the world's oil fields, and the comparative costs of coal and oil for power, a recent consular report[1] contains some interesting data, of which the following is a portion:

"The World's Resources of Coal.

"To forecast with any degree of accuracy the future of oil fuel for industrial purposes in Great Britain it is necessary to consider the relative world supplies of coal and oil, their relative economy in practice, and their relative efficiency. In normal times the world's approximate consumption of coal amounts to 1,200,000,000 tons, of which total Great Britain normally produces about 275,000,000 tons. The normal domestic and industrial consumption of coal per year in Great Britain is 190,000,000 tons; the rest of Great Britain's production is exported.

"On the basis of expert figures that 4¼ barrels of oil fuel are equal to 1 ton of coal, the world must produce 5,100,000,000 barrels of oil per year in order to replace coal fuel with oil throughout the world. The present production of oil in the world is only 550,000,000 barrels. So that the world's present output of oil is only sufficient to replace about 11 per cent of the coal. In other words, if all the oil produced in the world were shipped to Great Britain, it would be insufficient to replace the coal consumed in Great Britain for domestic and industrial purposes.

"British Coal Supplies—Expansion in Use of Oil.

"It has been estimated that the known available coal fields of the world insure an adequate supply of the normal needs of the world for the next 4000 years. This, of course, does not take into consideration the possibilities of the discovery of vast new fields which undoubtedly exist. While Great Britain's visible coal resources constitute only approximately 3½ per cent of the total coal resources of the world, it is estimated that with proper care and economy in working, Great Britain's coal should be sufficient for its requirements for the next 500 years.

"As for oil, there is absolutely no certainty as to available supplies. Undoubtedly large reservoirs of oil exist in the world which have not yet been discovered. But no estimate can be made in any field as to the period of exhaustion for that field. Already the navies of the world go far toward consuming at least a third of the oil produced in the world. In addition to this the conversion and the construction of oil-burning ships in the mercantile marines of the various maritime nations has led to a further consumption of oil as fuel. Thus the expansion in the use of fuel oil is bidding fair to rapidly outstrip its present production.

"Relative Efficiency of the Two Fuels.

"Turning from oil to coal, an average ton of British coal is supposed to have heating value of 12,000 British thermal units per pound, and the average price may be taken as £2 per ton. Basing the price of oil at £6 per ton and the heating value of oil at 18,000 B. t. u. per pound, we find that oil as fuel costs twice as much as coal.

"Mr. Davis Brownlie, in a recent computation of the relative efficiency of coal and oil as fuel, takes as a reasonable and fair comparison under moderately good attention 80 per cent efficiency for oil and 72½ per cent efficiency for coal. This gives 1 ton of oil at 18,000 B. t. u. and 80 per cent efficiency costing 6, as against 1 ton of coal at 12,000 B. t. u. and 72½ per cent efficiency costing 2 per ton.

"Mr. Brownlie's elementary deductions are, therefore, that 1 ton of oil is equal in net heating value to 1.65 tons of coal, and to produce the same amount of steam as from 1 ton of oil at 6 it would cost 3.30 if coal were used. In other words, if a manufacturer were spending 10,000 a year on coal for his boiler plant, oil would cost him 18,000 a year. Therefore, for most boiler plants the only result of oil firing would be a heavy loss.

[1]Page, Wilbur J., U. S. Trade Comm., London, England: The future of oil as fuel in Great Britain, U. S. Commerce Reports, No. 156, p. 107, July 7, 1921.

"Hydroelectric Power the Development of the Future.

"In view of the uncertainty of the world's future supply of oil and the great question as to whether, granting all the possible advantages in the use of oil as a fuel, in most cases real practical economy can be effected, there is room for doubt that the boom in the use of oil as fuel will reach the proportions during future generations sometimes predicted for it. Unquestionably the world has squandered its coal resources in the past, and this waste is still continuing. It is estimated that in Great Britain alone the domestic and industrial consumption of coal could be reduced at least 50,000,000 tons per year by adopting more economical methods. This saving would represent 200,000,000 barrels of oil per year, an amount equal to the oil production of all the countries of the world, excluding the United States.

"In the opinion of some of the foremost students of the subject, the future power supply of the world depends not on oil but on water, and the outstanding development of power supply will take the form of utilization of rivers, streams, and, possibly, the ocean tides."

So far as the Pacific Coast of the United States is concerned, it should be noted that oil is still cheaper than coal, which sells for about $8.00 per ton on Puget Sound, Washington, as against $6.47 for an equivalent amount of oil (3½ barrels) at the same point of delivery.

CHAPTER THREE.

METALS.

The total value of metals produced in California during 1920 was $19,989,487. The chief of these is, and always has been, gold, followed in order in 1920 by silver, quicksilver, lead, zinc, platinum, manganese, and iron. Deposits of ores of nickel and vanadium have also been found in the state, although there has as yet been no commercial output of them. There was no production of antimony, cadmium, molybdenum, nor tungsten in 1920. The above total value is a net decrease of $4,487,734 from the 1919 total of $24,477,221. This was due mainly to the marked drop in gold, copper, and quicksilver. Silver, lead, iron, and platinum showed increases in the order named.

California leads all states in the Union in her gold production, and the precious metal is widely distributed throughout the state. Twenty-nine of the fifty-eight counties reported an output in 1919 from either mines or dredges.

Copper, which is second in importance among the metals of the state, occurs in the following general districts: the Shasta County belt, which is by far the most important; the Coast Range deposits, extending more or less continuously from Del Norte in the north to San Luis Obispo County in the south; the Sierra Nevada foothill belt, starting in Plumas and running in a general southerly and southeasterly direction through the Mother Lode counties and ending in Kern; the eastern belt in Mono and Inyo counties; and the southern belt, in San Bernardino, Riverside, and San Diego counties.

Silver is not generally found alone in the state, but is associated to a greater or less extent with gold, copper, lead, and zinc.

Quicksilver has for many years been one of the state's staple products and California supplies approximately 75% of the nation's output of this metal.

Tungsten is found in but few other localities of importance in the United States.

Large deposits of iron ore have long been known in several sections of the state, but for various economic reasons this branch of the mineral industry thus far has made only slight progress here.

A comparison of the 1920 metal output with that of 1919 is afforded by the following table:

Metal	1919		1920		Decrease— Increase+ Value
	Amount	Value	Amount	Value	
Copper	22,162,605 lbs.	$4,122,246	12,947,299 lbs.	$2,382,303	$1,739,943—
Gold		16,695,955		14,311,043	2,384,912—
Iron ore	2,300 tons	13,796	5,975 tons	40,889	27,093+
Lead	4,139,562 lbs.	219,397	4,903,738 lbs.	392,300	172,903+
Manganese ore	11,553 tons	451,422	2,892 tons	62,323	389,099—
Platinum	418 fine oz.	60,611	477 fine oz.	68,977	8,366+
Quicksilver	15,200 flasks	1,353,381	10,278 flasks	775,527	577,854—
Silver		1,240,051		1,859,896	619,845+
Tungsten concentrates	214 tons	219 316			219,316—
Zinc	1,384,192 lbs.	101,046	1,188,000 lbs.	96,229	4,817—
Totals		$24,477,221		$19,989,487	
Net decrease					$4,487,734—

ALUMINUM.

Bibliography: Bulletins 38, 67.

No workable deposits of bauxite have as yet been discovered in the state, although from time to time small quantities of the impure material have been the foundation of extravagant reports regarding such discoveries.

Minerals containing aluminum are abundant, the most widely distributed being the clays. There are only two, however, thus far of consequence, commercially, in the production of the metal: bauxite (to which may be added the related, hydrated oxides, hydrargillite and diaspore), and cryolite. Cryolite is found in commercial quantities only in South Greenland, and was formerly the only ore of aluminum used, being still employed as a flux in the extraction of the metal. Bauxite has been, for some years, the most important source of aluminum and its salts. Its color varies from gray to red, according to the amount of iron present, the composition ranging usually between the following limits: Al_2O_3, 30%–60%; Fe_2O_3, 3%–25%; SiO_2, 0.5%–20%; TiO_2, 0.0%–10%. Besides its reduction to the metal, bauxite is also utilized in the manufacture of: aluminum salts, refractory bricks alundum (fused alumina) for use as an abrasive; and in the refining of oil (stated to be of growing importance). The most important producing countries, both of bauxite and the metal, are the United States and France, the former yielding more than 60 per cent of the world's output. In 1913 France led.

Because of its light weight (2.58 specific gravity), the metal, aluminum, has many important industrial uses, particularly in the manufacture of aeroplanes, airships, automobiles, cooking utensils, and electrical apparatus. The use of aluminum dust in place of zinc dust for

precipitating precious metal from cyanide solutions is increasing. In the Thermit process of welding and casting, aluminum in fine grains or filings is mixed with the oxide (usually iron oxide) to be reduced.

ANTIMONY.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38.

Antimony is known to exist in a number of places in California, having been reported from Kern, Inyo, Nevada, Riverside, San Benito, and Santa Clara counties. The Kern County deposits, some of which carry the native metal, are possibly the best known, and efforts were made to work some of them before California was a part of the United States. The commonest occurrence is in the form of the sulphide, stibnite. No continuous production, however, has been maintained, the output for 1915 to 1917 inclusive, being the first reported since 1901. There has been none produced since 1917.

Pure antimony metal, and manufactured antimony compounds are of considerable importance as pigments in the ceramic industry. The most important use of the metal, commercially, is in various alloys, particularly type-metal (with tin and lead), babbitt (with tin and copper), and Britannia metal (with tin and copper).

From the low point of 5.44¢ to 7.11¢ per pound, according to brand, in July, 1914, the price of antimony rose gradually, though not steadily, to 44¢ by the middle of January, 1916. American antimony, for the first time in many years, appeared on the market in competition with the Chinese and Japanese product. From $1 to $2.25 per unit was paid for ore, and at first a minimum of 50% accepted; but, later, some lower grade ore was smelted. The price remained at 44¢ (San Francisco quotations) until the middle of April, 1916, then declined quite rapidly to 10¢ in August. It varied around 10¢ to 14¢ during most of 1917 and 1918. With the price below 12¢ per pound for the metal, few if any of the California mines can operate profitably. New York prices during 1920 averaged 8.5¢ per pound.

The production of antimony by years since 1887 has been as follows:

Year	Tons	Value	Year	Tons	Value
1887	75	$15,500	1900	70	$5,700
1888	100	20,000	1901	50	8,350
1893	50	2,250	1915	510	35,666
1894	150	6,000	1916	1,015	64,793
1895	33	1,485	1917	158	18,786
1896	17	2,320	1918		
1897	20	3,500			
1898	40	1,200			
1899	75	13,500	Totals	2,363	$199,050

ARSENIC.

Bibliography: Bulletin 67. U. S. G. S., Min. Res. of U. S.

Arsenic occurs in a number of localities in California in the mineral, arseno-pyrite, which is frequently gold bearing. To date, there has been no commercial output of arsenic from California ores. The principal source of the arsenic of commerce in the United States has been as a by-product from the metallurgical treatment of copper, gold, and lead ores. It is usually recovered in the form of the tri-oxide, or 'white arsenic.'

BISMUTH.

Bibliography: Bulletins 38, 67. Am. Jour. Sci. 1903, Vol. 16.

Several bismuth minerals have been found in California, notably native bismuth and bismite (the ochre) in the tourmaline gem district in San Diego and Riverside counties near Pala. Other occurrences of bismuth minerals, including the sulphide, bismuthinite, have been noted in Inyo, Fresno, Nevada, Tuolumne, and Mono counties, but only in small quantities. The only commercial production recorded was 20 tons valued at $2,400, in 1904, and credited to Riverside County.

In 1917, a few pounds of bismuthinite (Bi_2S_3) with associated bismutite ($Bi_2CO_5.H_2O$), was taken out at the United Tungsten Copper mine, in the Morongo district, San Bernardino County. It is associated with scheelite in a contact deposit between limestone and granite.

Recovery of bismuth from blister copper in the electrolytic refinery has been noted,[1] ranging as high as 27.3 pounds of metallic bismuth per 100 tons of blister copper from the Iron Mountain, Shasta County, ores. In the United States, the principal recovery of bismuth is obtained from the refining of lead bullion.

The uses of bismuth are somewhat restricted, being employed principally in the preparation of medicinal salts, and in low melting-point or eliché alloys. These alloys are utilized in automatic fire sprinkler systems, in electrical fuses, and in solders.

The market value of bismuth metal produced in the United States in 1920 averaged $2.22 per pound.

CADMIUM.

Bibliography: U. S. G. S. Min. Res. of U. S., 1908, 1918.

In 1917 and in 1918, several thousand pounds of cadmium metal, in sticks, was recovered by the electrolytic zinc plant of the Mammoth Copper Company in Shasta County. The 1917 output was the first

[1]Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217-218.

commercial production of this metal recorded in California. As there was only the one producer, the exact figures and value were concealed under the 'unapportioned' item.

The cadmium there occurs associated with zinc sulphide, sphalerite, probably as the sulphide, greenockite. There are several cadmium minerals, but none of them occur in sufficient quantities individually to be profitable as distinct ores. The cadmium of commerce is derived as a by-product in the reduction of zinc minerals and ores, in nearly all of which it occurs in at least minute proportions, the average ratio being about 1 of cadmium to 200 of zinc. As cadmium behaves metallurgically much the same as zinc, it constitutes a fraction of 1 per cent of nearly all metallic zinc.

Cadmium is produced in the United States in two forms—metallic cadmium and the pigment, cadmium sulphide. The principal use of the metal is in low-melting point, or cliché alloys, and its salts are utilized in the arts, medicine, and in electroplating. The sulphide is employed as a paint pigment, being a strong yellow. Cadmium cliché metal is stated to be superior to the corresponding bismuth alloy, for making stereotype plates. Cadmium is also used in bronze telegraph and telephone wires.

In the last year of the war (1918), the United States Government[1] and certain large concerns began experiments with cadmium solder as a means of saving tin. The results of these experiments were promising, but the demand for tin decreased, and the armistice was signed before cadmium solders became widely used. Cadmium was used by European nations during the war for some strictly military purposes, but little exact information is available to show those purposes. Germany was the first of the belligerent nations to make large use of cadmium as a substitute for tin in solders, being cut off by the blockade almost entirely from the world's sources of tin.

The highest average annual price recorded for cadmium produced in the United States was $1.56 per pound, in 1916. In 1919, the average prices of the metal and the sulphide were $1.22 and $1.20 per pound, respectively; and, in 1920, $1.17 and $1.16, respectively.

COBALT.

Bibliography: Report XIV; Bulletin 67. U. S. G. S., Min. Res. of U. S., 1912, 1918.

Occurrences of some of the cobalt minerals have been noted in several localities in California, but to date no commercial deposits have been developed. Some of the copper ores of the foothill copper belt

[1]U. S. G. S. Press Bull. No. 407, May, 1919, p. 1.

in Mariposa and Madera counties have been found to contain cobalt up to 3%.

The most important use of cobalt is in the manufacture of the alloy, stellite, in which it is combined with chromium, for making high-speed lathe tools, and non-tarnishing cutlery and surgeons' appliances. The metal is also used in electroplating, similarly to nickel; and the oxide, carbonate, chloride, sulphate and other salts are used in ceramics for coloring. Some of the organic salts of cobalt (acetate, resinate, oleate) are employed as 'driers' in paint and varnish.

Quotations for the metal reached $6 per pound during the war; and at present (July, 1921) are around $4 per pound.

COPPER.

Bibliography: State Mineralogist Reports VII, XIII, XIV, XV. Bulletins 23, 50.

Copper is second only to gold among the metals produced in California. For many years Shasta was the leading county in the output of the red metal, but in 1919, Plumas advanced to first place. In 1920, Calaveras County also passed Shasta. This was due to the maintenance of output level by the Engels and Walker properties in Plumas County, by the Calaveras in Calaveras County, and to the shutting down of the Mammoth, Mountain and Afterthought properties in Shasta County. Both the Engels and Walker mines have flotation plants in operation, and ship the concentrates to smelters outside of the state. Other important producing counties in 1920 were Siskiyou, Inyo, and Madera, in the order named. Although the copper workings of the Mountain Copper Co. were closed down in 1920, a part of the year's copper credited to Shasta County was obtained as a by-product from pyrite which had been sold and utilized in the manufacture of sulphuric acid, after which the cinder was smelted at other plants.

In 1920, some yield in greater or less amount was reported from a total of 14 counties, as against 16 counties in 1919, and 24 in 1918. The total production for 1920 was 12,947,299 pounds, or approximately 60% of the 1919 figures, which, in turn, were less than one-half of the 1918 output. The value was $2,382,303. The price of copper in recent years has ranged from 13.3¢ average for the year 1913 to 27.3¢ in 1917, dropping to 18.6¢ in 1919, and 18.4¢ in 1920. The present quotations (July, 1921) are around 13¢ per pound. With two or three notable exceptions, of which the Engels in Plumas County is the most

prominent, practically all of the copper mines in California are at present idle. The same state of affairs also exists in the other western copper-producing states: Arizona, Montana, Nevada, and Utah.

New mill of The Engels Copper Company, Plumas County. Photo by courtesy of the Mining and Scientific Press.

Flotation concentration is successfully employed at a number of the copper mines in California, notably by the Engels Copper Company and the Walker Mine in Plumas County, the Calaveras Copper Company in Calaveras County, and the Mammoth Copper Company in

Shasta County. A leaching plant built near Raymond handles ores from the Green Mountain copper mine in Mariposa County. Bluestone, cement copper, and other by-products are made.

Tramway terminal and head frame at the Superior Mine, Engels Copper Company, Plumas County. Photo by courtesy of the Mining and Scientific Press.

Distribution of the output by counties, for 1920, was as follows:

County	Pounds	Value
Calaveras	2,112,186	$388,642
Inyo	144,286	26,549
Kern	206	38
Madera	89,846	16,532
Mono	3,215	592
Orange	455	84
Plumas	9,583,834	1,763,425
San Bernardino	5,385	991
Shasta	810,843	149,195
Del Norte, Los Angeles, Mariposa, Nevada, San Luis Obispo, Siskiyou*	197,042	36,255
Totals	12,947,299	$2,382,303

*Combined to conceal output of a single operator in each.

Amount and value of copper production in California annually since such records have been compiled by the State Mining Bureau is given in the following tabulation:

Year	Pounds	Value	Year	Pounds	Value
1887	1,600,000	$192,000	1905	16,997,489	$2,650,605
1888	1,570,021	235,303	1906	28,726,448	5,522,712
1889	151,505	18,180	1907	32,602,945	6,341,387
1890	23,347	3,502	1908	40,868,772	5,350,777
1891	3,397,455	424,675	1909	65,727,736	8,478,142
1892	2,980,944	342,808	1910	53,721,032	6,680,641
1893	239,682	21,571	1911	36,838,024	4,604,753
1894	738,594	72,486	1912	34,169,997	5,638,049
1895	225,650	21,901	1913	34,471,118	5,343,023
1896	1,992,844	199,519	1914	30,491,535	4,055,375
1897	13,638,626	1,540,666	1915	40,968,966	7,169,567
1898	21,543,229	2,475,168	1916	55,809,019	13,729,017
1899	23,915,486	3,990,534	1917	48,534,611	13,249,948
1900	29,515,512	4,748,242	1918	47,793,046	11,805,883
1901	34,931,788	5,501,782	1919	22,162,605	4,122,246
1902	27,860,162	3,239,975	1920	12,947,299	2,382,303
1903	19,113,861	2,520,997			
1904	29,974,154	3,969,995	Totals	816,243,502	$136,643,732

GOLD.

Bibliography: State Mineralogist Reports I to XV (inc.). Bulletins 36, 45, 57. U. S. G. S., Prof. Pap. 73.

Gold is one of the most important mineral products of California. For a number of years up to 1916 there was a marked tendency toward increased activity in gold mining, as investors realized that many of the mines and prospects have not been exhausted. The increase in costs of all supplies, labor and transportation since 1915 has made it

increasingly difficult for the gold miner to operate at a profit. The gold output of not only California, but of the other western gold states has decreased greatly. Many of the mines have been forced to close down.

The gold miner is decidedly at a disadvantage. The prices of other metals and products can be raised to meet conditions; but the gold miner's dollar, being the base, has to remain at the same face value though its purchasing power has dropped to approximately one-half. A bill has been introduced in Congress to provide for a subsidy on new gold produced in the United States. When conditions again assume a normal trend, gold mining will again increase; but it will probably take several years.

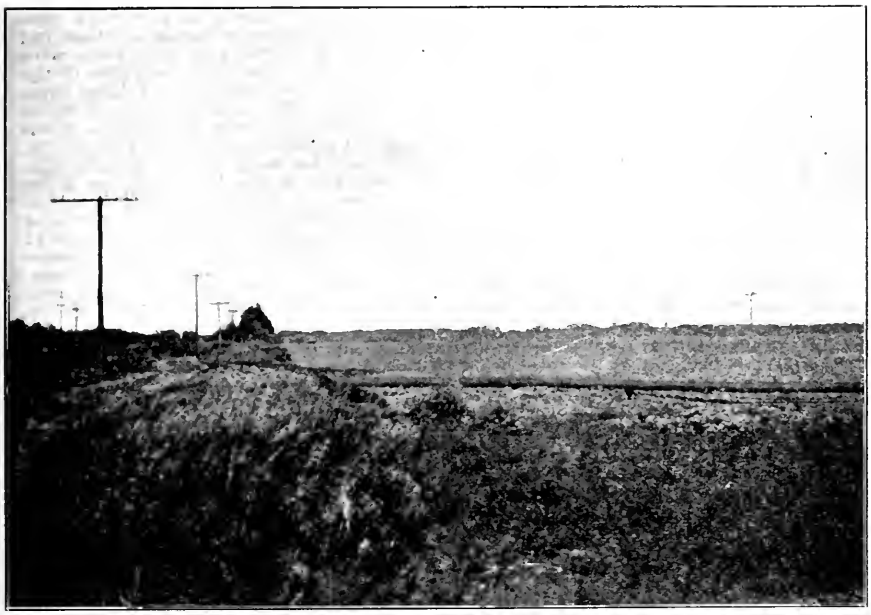
There is one branch of gold mining, however, that has apparently passed its zenith in California—that of dredging. The available ground at Oroville, in Butte County, the oldest field in the state, is nearly worked out. Some re-dredging will be done by larger, modern machines in the earliest ground worked there, but not over the entire area. In May, 1920, there were but four boats in operation at Oroville.

The State Mining Bureau has never independently collected statistics of gold and silver production, as there is no necessity for duplicating the very thoroughly organized work of the U. S. Geological Survey covering those metals. The data here given relative to these two metals has been received through the courtesy and cooperation of Mr. Charles G. Yale, Statistician in Charge of the San Francisco branch office of the Division of Mineral Resources. Anyone wishing fuller details of the production of these metals may obtain the same by applying to the U. S. Geological Survey, Washington, D. C., or to room 305, U. S. Custom House, San Francisco, California, for a copy of the 'separate' on the subject.

There was a decrease of $2,384,912 in the 1920 gold output of California, compared to the 1919 yield of $16,695,955; and the outlook for 1921 is not showing much improvement. Among those that have been large producers, the Argonaut and Kennedy mines in Amador County were nonproductive for several months on account of an underground fire, the flooding of the workings to conquer it; then having to pump the water out; and the North Star mine in Nevada County has been working at only part capacity. In addition to these, two of the large copper smelters, the Mammoth and the Mountain,

which yielded important amounts of gold and silver, have been shut down since early in 1919. A notable exception to the above described depression among the gold producers is the Carson Hill group, which includes the famous Morgan mine, in southern Calaveras County. Current reports credit this property with continuing a fairly steady output of approximately $100,000 per month.

Although local newspapers report some renewal of inquiries for, and activity in, gold properties particularly along the Mother Lode, it



Dredged land as left by the re-soiling dredge of Natomas Company of California, near Natoma, Sacramento County.

has not yet made itself felt in the bullion column. According to the mid-year review of Yale,[1] mint and smelter receipts for the first six months of 1921 have totaled only $7,362,294 in gold, or $482,000 less than during the first six months of 1920.

"No sign of immediate improvement in gold mining in California can be seen. The cost of supplies has diminished somewhat, but wages continue to be a source of contention between the operators and the miners' unions. Within a few weeks two of the most productive deep mines of the State will probably be added to the number that are closed down. At one of the larger mines, which crushed more than 60,000 tons of ore last year, the cost of producing gold was $19.15 an ounce, and this property has perhaps the best-equipped reduction plant in California, making a total recovery of 97½ per cent.

[1]Yale, Chas. G., U. S. Geol. Surv., Press Bulletin, July 21, 1921.

"The decrease in output does not affect equally the deep and the placer mines. The output of the deep mines appears to be falling off about 16 per cent, whereas that of the placers is falling off only 12 per cent. The placer gold output is kept up mainly by the dredgers, which show little total loss, but other forms of placer mining are not so prosperous as formerly. The supply of water this year, however, has been much more favorable for the placers than in 1920."

The following is quoted from the advance chapter on Gold in 1920, by courtesy of Mr. Charles G. Yale, of the U. S. Geological Survey:

"The general conditions of the metal-mining industries in California in 1920 were more unfavorable than has been the case in many years. These were much the same as in the other Western States, such as high cost of skilled labor and supplies, burden of war taxation, high freight rates, labor union troubles, etc., causing numerous mines to be closed down entirely and others to curtail operations. The decrease is due entirely to a smaller output of gold by $2,384,912 and of copper by $1,719,012 than in 1919, for increases are shown in the quantities and values of the silver, lead and zinc. Several of the larger and almost all of the smaller copper properties were unproductive. The larger gold mines all curtailed operations, many of them to the extent of 50 per cent, and numbers ceased work for the time, while several closed down permanently and allowed the mines to fill with water. The smaller deep gold mines were much fewer in number than usual and made lessened outputs. From placer mines the reports received were discouraging in all forms of gravel-mining dredge, hydraulic, drift, and surface—the total gold from these sources being $972,463 less than in 1919. The deep mines, however, were even worse off, the deficit for the year being $1,412,449, as compared with 1919. The cost of producing an ounce of gold at the deep mines has been steadily rising until it has reached such a point that mining for it has become almost prohibitive under present conditions. From a cost of $9.51 an ounce in 1913 it has gone up to $19.15 an ounce in 1920, even among the larger mines with fully equipped and carefully managed reduction plants. It is this condition which has caused the closing down or lessened operations at so many gold mines, more particularly the deep ones, but affecting to some extent the gravel mines also.

"In the five Mother Lode counties of the state, one of which contains the deepest gold mines, 38 per cent of the total ore milled or shipped was treated. The output of ore in these counties was 339,930 tons less than in 1919 and the value of total recovery $1,434,416 less. The value of total recovery per ton, however, has risen to $7.851 in 1920 from $6.270 per ton in 1919.

"The average value of all metals from ores of the state in 1920 was $10.20 a ton, as compared with $8.24 a ton in 1919. From ordinary ore sent to gold and silver mills the recovery in batteries, plates, etc., was $8.340 a ton in gold and $0.159 in silver, compared with $5.927 a ton in gold and $0.118 in silver in 1919. The recovery from the concentrates treated was $24.215 per ton in gold and $6.343 per ton in silver. Crude ores of all kinds sent to smelters averaged $8.278 in gold and $41.718 in silver. Old tailings treated—33,540 tons—averaged $1.501 in gold and $0.763 in silver.

* * * * * * *

"The total mine production of gold in California in 1920 was 692,296.70 fine ounces, valued at $14,311,043, a decrease of 115,370.12 fine ounces, valued at $2,384,912 from the production of 1919. This decrease was due to conditions described elsewhere in this chapter. The deep mines of the State yielded 350,739.55 fine ounces, valued at $7,250,430, which was a decrease of 68,327.22 fine ounces, valued at $1,412,449. Of the deep-mine gold 99 per cent was derived from siliceous ore.

"The yield of placer-mine gold was 341,557.15 fine ounces, valued at $7,060,613, which is $972,463 less than in 1919. The dredges of the state yielded $6,900,366 in gold in 1920, which is $816,553 less than in 1919. From 1898, when gold dredging began in California, to the end of 1920 the total gold output from that source has been $117,236,197. Since 1898 the Oroville or Feather River dredging field, in Butte County, has yielded $31,338,086, not including $2,496,890 derived in the last 11 years from adjacent fields in the same county; from 1903 to 1920, inclusive, the Marysville or Yuba River field in Yuba County, produced $39,511,478 in gold and since 1902 the Folsom or American River field, in Sacramento County, has produced $26,813,403 in gold. Dredges have also been operated in several smaller fields in other northern counties of the state.

"The placer mines produced 49 per cent of the gold yield in 1920 and the deep mines 51 per cent, as compared with 48 per cent for the placer and 52 per cent for the deep mines in 1919. The dredges produced 48 per cent of the total gold from all sources in 1920. Of the total placer gold the dredges produced about 98 per cent, the hydraulic mines 0.9 per cent, drift mines 0.8 per cent, and sluicing mines 0.4 per cent. The larger dredging fields are at Oroville, Butte County; Folsom, Sacramento County; and Hammonton, Yuba County; but dredges are also operated in 8 other counties—1 in Amador, 2 in Calaveras, 1 in Placer, 1 in San Joaquin, 4 in Shasta, 2 in Siskiyou, 2 in Stanislaus, and 4 in Trinity County. There were 40 dredges reporting production in California in 1920, or less than in 1919, and several of these quit work before the end of the year, having worked out their ground. The Yuba County dredges, 10 in number, made the largest output of gold in 1920, the value being $3,456,452, a decrease of $729,474. Sacramento County, with 9 dredges at work, produced $1,574,744, a decrease of $137,961. In Butte County (including Oroville and the "outside districts") 4 dredges produced $441,650, or $80,046 more gold than in 1919.

"Of the 28 counties producing gold in California in 1920, 6 yielded no placer gold and 3 produced no gold from deep mines. Five counties produced more than $1,000,000 each in gold in 1920, as follows: Yuba, $3,467,769; Nevada, $2,872,471; Amador, $1,788,793; Sacramento, $1,575,033; and Calaveras, $1,439,745. The most productive county in deep-mine gold was Nevada, with $2,860,557. The leading producer of gold from dredges was Yuba; the gold output from hydraulic mines was largest in Siskiyou; in drift mining, Butte led; and surface placer output was greatest in Fresno. The largest increase in gold in 1920 was made in Sierra County ($141,722), which was followed by Mono ($115,318), Butte ($89,603), San Bernardino ($39,426), Stanislaus ($37,939), Plumas ($18,497), Mariposa ($8438), and a few others with smaller increases. The greatest decrease in gold output was in Amador ($1,131,699), followed by Yuba ($727,963), Sacramento ($139,160), Calaveras ($110,829), and Nevada ($108,841), and some others less than $100,000.

* * * * * * *

"The 1919 productive placer mines of California in 1920 yielded gold valued at $7,060,613 and silver valued at $32,591. The decrease in placer gold was $972,463 and the increase in silver $1316. In production of placer gold the dredges showed a decrease of $816,553, the hydraulic mines $118,599, and the drift mines $22,416, and the surface placers a decrease of $14,895. Thus it is seen that all forms of gold mines shared in the general decrease of gold output of the state in 1920."

The gold production of California for 1920 was distributed, by counties, as follows:

County	Value	County	Value
Amador	$1,788,793	Plumas	$102,097
Butte	467,900	Sacramento	1,575,033
Calaveras	1,439,745	San Bernardino	79,195
El Dorado	13,379	Shasta	312,901
Fresno	7,793	Sierra	442,894
Humboldt	2,538	Siskiyou	86,707
Inyo	55,634	Stanislaus	142,467
Kern	61,187	Trinity	541,387
Madera	6,382	Tuolumne	254,569
Mariposa	261,830	Yuba	3,467,769
Mono	144,746	Alpine, Los Angeles, Modoc, San Joaquin*	38,393
Nevada	2,872,471		
Orange	145		
Placer	151,088	Total value	$14,311,043

*Combined to conceal output of a single operator in each.

Total Gold Production of California.

The following table was compiled by Chas. G. Yale, of the Division of Mineral Resources, U. S. Geological Survey, but for a number of years statistician of the California State Mining Bureau and the U. S. Mint at San Francisco. The authorities chosen for certain periods were: J. D. Whitney, state geologist of California; John Arthur Phillips,

author of "Mining and Metallurgy of Gold and Silver" (1867); U. S. Mining Commissioner R. W. Raymond; U. S. Mining Commissioner J. Ross Browne; Wm. P. Blake, Commissioner from California to the Paris Exposition, where he made a report on "Precious Metals" (1867); John J. Valentine, author for many years of the annual report on precious metals published by Wells, Fargo & Company's Express; and Louis A. Garnett, in the early days manager of the San Francisco refinery, where records of gold receipts and shipments were kept. Mr. Yale obtained other data from the reports of the director of the U. S. Mint and the director of the U. S. Geological Survey. The authorities referred to, who were alive at the time of the original compilation of this table in 1894, were all consulted in person or by letter by Mr. Yale with reference to the correctness of their published data, and the final table quoted was then made up.

The figures since 1904 are those prepared by the U. S. Geological Survey:

Year	Value	Year	Value
1848	$245,301	1885	$12,661,044
1849	10,151,360	1886	14,716,506
1850	41,273,106	1887	13,588,614
1851	75,938,232	1888	12,750,000
1852	81,294,700	1889	11,212,913
1853	67,613,487	1890	12,309,793
1854	69,433,931	1891	12,728,869
1855	55,485,395	1892	12,571,900
1856	57,509,411	1893	12,422,811
1857	43,628,172	1894	13,923,281
1858	46,591,140	1895	15,334,317
1859	45,846,599	1896	17,181,562
1860	44,095,163	1897	15,871,401
1861	41,884,995	1898	15,906,478
1862	38,854,668	1899	15,336,031
1863	23,501,736	1900	15,863,355
1864	24,071,423	1901	16,989,044
1865	17,930,858	1902	16,910,320
1866	17,123,867	1903	16,471,264
1867	18,265,452	1904	19,109,600
1868	17,555,867	1905	19,197,043
1869	18,229,044	1906	18,732,452
1870	17,458,133	1907	16,727,928
1871	17,477,885	1908	18,761,559
1872	15,482,194	1909	20,237,870
1873	15,019,210	1910	19,715,440
1874	17,264,836	1911	19,738,908
1875	16,876,009	1912	19,713,478
1876	15,610,723	1913	20,406,958
1877	16,501,268	1914	20,653,496
1878	18,839,141	1915	22,442,296
1879	19,626,654	1916	21,410,741
1880	20,030,761	1917	20,087,504
1881	19,223,155	1918	16,529,162
1882	17,146,416	1919	16,695,955
1883	24,316,873	1920	14,311,043
1884	13,600,000	Total	$1,720,218,101

IRIDIUM (see under Platinum).

IRON ORE.

Bibliography: State Mineralogist Reports II, IV, V, X, XII, XIII, XIV, XV. Bulletins 38, 67. Am. Inst. Eng., Trans. LIII. Min. & Sci. Press, Vol. 115, pp. 112, 117–122.

Iron ore to the amount of 5,975 tons, valued at $40,889, was produced in California during the year 1920, and utilized for foundry flux, and in steel refining at open-hearth plants. This is an increase over the 2,300 tons and $13,796 of 1919, and is the largest amount for a single year since 1883.

Magnetite and limestone quarries of the Noble Electric Steel Corporation on property of the Shasta Iron Company, near Heroult, Shasta County. Photo by C. A. Waring.

There are considerable deposits of iron ore known in California, notably in Shasta, Madera, Placer, Riverside and San Bernardino counties, but production has so far been limited, on account of our having no economic supply of coking coal. Some pig-iron has been made, utilizing charcoal for fuel, both in blast furnaces and by electrical reduction. Further developments along the line of electrical smelting, or discoveries making available our petroleum fuel, for iron reduction, would lead to considerable increase of iron mining in California. For the present, at least, the most feasible possibilities lie in utilizing our iron resources in the preparation of the various alloys such as ferro-chrome, ferro-manganese, ferro-molybdenum, ferro-silicon and ferro-

tungsten, by means of the electric furnace. California possesses commercial deposits of ores of all of the metals just enumerated.

Total iron ore production in the state, with annual amounts and values, is as follows:

Year	Tons	Value	Year	Tons	Value
1881*	9,273	$79,452	1910	579	$900
1882	2,073	17,766	1911	558	558
1883	11,191	106,540	1912	2,508	2,508
1884	4,532	40,983	1913	2,343	4,485
1885			1914	1,436	5,128
1886	3,676	19,250	1915	724	2,584
1887			1916	3,000	6,000
1893	250	2,000	1917	2,874	11,496
1894	200	1,500	1918	3,108	15,947
1895			1919	2,300	13,796
1907	400	400	1920	5,975	40,889
1908					
1909	108	174	Totals	57,088	$472,356

*Productions for the years 1881-1886 (inc.) were reported as "tons of pig iron," (U. S. G. S., Min. Res. 1885), and for the table herewith are calculated to "tons of ore" on the basis of 47.6% Fe as shown by an average of analysis of the ores (State Mineralogist's Report IV, p. 242). This early production of pig iron was from the blast furnaces then in operation at Hotaling in Placer County. Charcoal was used in lieu of coke. Though producing a superior grade of metal, they were obliged finally to close down, as they could not compete with the cheaper English and eastern United States iron brought in by sea to San Francisco.

LEAD.

Bibliography: State Mineralogist Reports IV, VIII, X, XV.

Lead production in California in 1920 increased slightly over that of the preceding year, both in quantity and value. The average price dropped from 8.6¢ in 1917 to 7.1¢ per pound in 1918; and to 5.3¢ in 1919; increasing in 1920 to 8.0¢. The pre-war prices were 3.9¢ in 1914 and 4.7¢ in 1915.

The principal production in this state comes from Inyo County, which contributed 94% of the 1920 yield, followed by San Bernardino, with smaller amounts in 1920 from Mono and Shasta.

County	Pounds	Value
Mono	85,014	$6,801
Inyo	4,612,338	368,987
Orange	15,932	1,275
San Bernardino	115,876	9,270
Shasta	64,400	5,152
Calaveras, Kern, Los Angeles, Mariposa, Nevada, Plumas*	10,178	815
Totals	4,903,738	$392,300

*Combined to conceal output of a single operator in each.

Statistics on lead production in California were first compiled by this Bureau in 1887. Amount and value of the output, annually, with total figures, to date, are given in the following table:

Year	Pounds	Value	Year	Pounds	Value
1887	1,160,000	$52,200	1905	533,680	$25,083
1888	900,000	38,250	1906	338,718	19,307
1889	940,000	35,720	1907	328,681	16,690
1890	800,000	36,000	1908	1,124,483	46,663
1891	1,140,000	49,020	1909	2,685,477	144,897
1892	1,360,000	54,400	1910	3,016,902	134,082
1893	666,000	24,975	1911	1,403,839	63,173
1894	950,000	28,500	1912	1,370,067	61,653
1895	1,592,400	49,364	1913	3,640,951	160,202
1896	1,293,500	38,805	1914	4,697,400	183,198
1897	596,000	20,264	1915	4,796,299	225,426
1898	655,000	23,907	1916	12,392,031	855,049
1899	721,000	30,642	1917	21,651,352	1,862,016
1900	1,040,000	41,600	1918	13,464,869	956,006
1901	720,500	28,820	1919	4,139,562	219,397
1902	349,440	12,230	1920	4,903,738	392,300
1903	110,000	3,960			
1904	124,000	5,270	Totals	95,605,889	$5,939,069

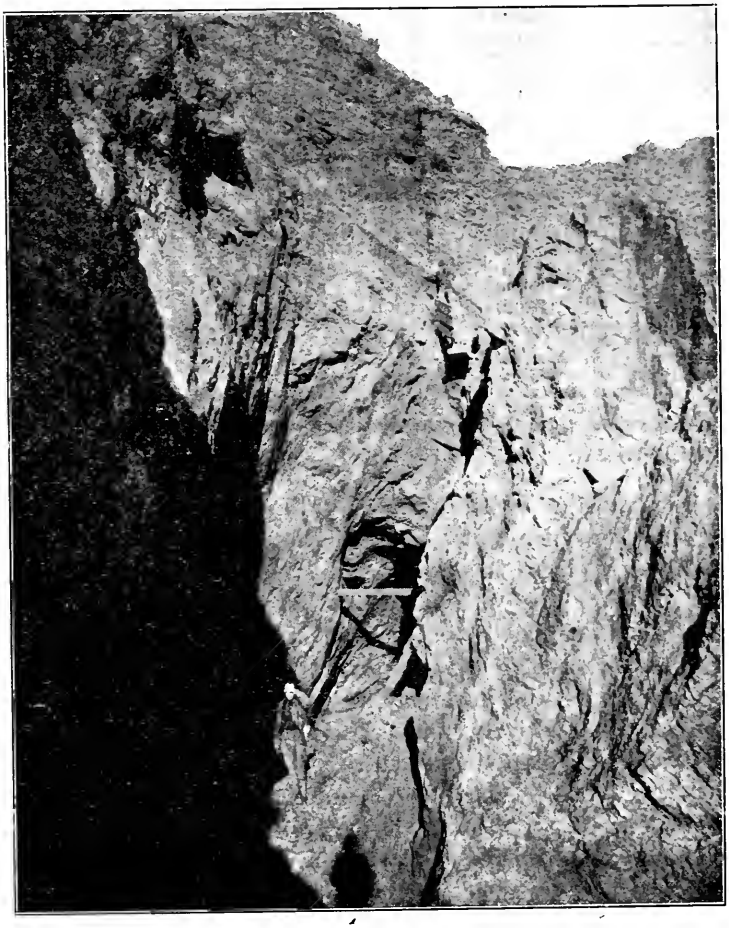
MANGANESE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletins 38, 67, 76. U. S. G. S., Bull. 427.

In the statistical reports previous to 1915, manganese ore was included in the 'industrial materials' list. In that year we made a transfer, and have since placed it under 'metals,' because by far the greater tonnage of manganese ore is utilized in the preparation of ferro-manganese and employed in the steel industry both for its metal content and to slag off certain impurities during the open-hearth treatment. Though its other uses may be classed as 'chemical,' the tonnage thus consumed is relatively smaller. Its chemical uses are as a decolorizer or oxidizer in glass manufacture, and as a constituent in electric dry batteries. The chemical uses require a much higher grade of ore than the steel industry. For steel purposes an iron content is acceptable, but manganese should exceed 40%. Silica should be under 8%, though higher was taken during the war period. Phosphorus should be under 0.20%. For electric dry cells, the iron content should be under 1.5% Fe_2O_3, and SiO_2, under 6%. For glassmaking the manganese should be practically free of iron. On account of the high prices prevailing for manganese during 1915-1918, it is stated that selenium was replacing it, in part at least, in glass factories.

Though the imports of manganese ore from the Caucasus district in Russia were reduced by the war to practically nothing (about 1% of 1914 figures), the United States received important shipments from Brazil, India and Cuba; so that the total imports for 1916 were

practically double those of either 1914 or 1915. The 1916 figures were 576,321 long tons, valued at $8,666,179; for 1917, a total of 629,972 long tons, valued at $10,262,929, of which 512,517 tons were from Brazil; in 1918 a total of 491,303 long tons, value $15,095,867, of which 345,877 tons were from Brazil; in 1919, a total of 333,344 long tons,



Open-cut stope of Buckeye Manganese Mine, Stanislaus County. Ore body extracted was 20′ wide and over 75′ long, of ore carrying 48% manganese. This mine was the largest single producer in California in 1918-1919.

value $11,229,184, of which 246,592 tons came from Brazil; in 1920, total 601,437 long tons, value $11,955,922, 421,523 tons, Brazil. The increased demand for steel products increased the necessity for ferro-manganese, which is used largely in the open-hearth process of steel making. This resulted in curtailment of ferro-manganese exports from England, and the resulting shortage in the United States was met by

the greater imports of manganese ore from Brazil especially, and an increased domestic production both of ore and ferro-manganese. These conditions caused the prices for the ores to range from $30 to $60 per ton, f.o.b. rail, California, for the steel grades, to above $75 for chemical grades, during 1917-1918.

Batteries, chemicals, and kindred industries in the United States consume approximately 25,000 tons of high-grade manganese ore, annually, or about one-thirtieth of that used in steel manufacture.

A considerable portion of the state's 1917 and 1918 product was utilized in California in making ferro-manganese by electric furnace; besides shipments which were sent East. Some 'chemical' ore was also shipped. For many years the principal producing section has been the Livermore-Tesla district, in Alameda and San Joaquin counties, but exceeded in 1915 by Mendocino and regaining the lead in 1916. In 1918-1920 the largest producing county was Stanislaus, which adjoins San Joaquin on the south, and whose manganese district is a part of the same geological province that includes the Livermore-Tesla district.[1] Humboldt County ranked second in 1920, with Mendocino third.

Manganese is reported to exist in many localities in the state; but for a number of years, particularly since the discontinuance of the chlorination process in the metallurgy of gold, production was relatively unimportant until the activity of the war period.

The production of manganese ore in California for 1920 amounted to 2,892 tons of all grades, having a total value of $62,323 f.o.b. railway shipping point. This was less than one-third of the quantity, and one-eighth of the value in 1919. The 1916 output nearly equaled the entire previous tonnage, 1887 to 1915, and was about double the value for the same period. Most of the 1919 output of California manganese was made during the first half of the year by a few companies that had uncompleted contracts running to July 1; but there were few shipments in the second half. In 1920, the market revived and several properties were reopened both in the Humboldt-Mendocino and the San Joaquin-Stanislaus districts. The prices averaged $21.70 per ton, f.o.b. California points for all grades, and the ores shipped ranged from 44% to 55%. Most of the 1920 tonnage went to eastern points for the manufacture of ferro-manganese. A part was used locally for electric dry-battery purposes.

Part of the 1920 California output was a concentrated product made at the plant of the Consolidated Manganese Co. in Berkeley from high-silica manganese ores by an electro-magnetic separation. About 75% of their material is obtained from the Livermore-Tesla district, and

[1] See Plate II, p. 24, Cal. State Min. Bur. Bulletin No. 76, 1918.

some has been treated carrying as high as 35% SiO_2. This plant is at present turning out 42 tons per month, of a product analyzing 54% Mn. and 7% SiO_2. This concentrate is sold to the large iron foundries for use, instead of ferro-manganese, in their cupola blast furnaces in making gray-iron castings. It is cheaper, and is stated to be equally, if not more, satisfactory than ferro-manganese for that purpose.

The 1920 output was distributed by counties as follows:

County	Tons	Value
Humboldt	859	$18,513
Lake	247	7,816
Stanislaus	893	12,973
Alameda, Mendocino, San Joaquin, San Luis Obispo*	893	23,021
Totals	2,892	$62,323

*Combined to conceal output of a single operator in each.

In 1918 there were two electric smelters in operation in California making ferro-alloys: the plant of the Noble Electric Steel Company at Heroult, Shasta County, and the newer one of the Pacific Electro Metals Company at Bay Point, Contra Costa County. Both were idle in 1919–1920.

Production of manganese ore in California began at the Ladd Mine, San Joaquin County, in the Tesla District in 1867. When shipments of this ore to England ceased late in 1874, upwards of 5,000 tons had been produced by that property. For some years following that, the output was small. The tabulation herewith shows the California output of manganese ore, annually, since 1887, when the compilation of such figures was begun by the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1887	1,000	$9,000	1905		
1888	1,500	13,500	1906	1	$20
1889	53	901	1907	1	25
1890	386	3,176	1908	321	5,785
1891	705	3,830	1909	3	75
1892	300	3,000	1910	265	4,235
1893	270	4,050	1911	2	40
1894	523	5,512	1912	22	400
1895	880	8,200	1913		
1896	518	3,415	1914	150	1,500
1897	504	4,080	1915	4,013	49,098
1898	440	2,102	1916	13,404	274,601
1899	295	3,165	1917	15,515	396,659
1900	131	1,310	1918	26,075	979,235
1901	425	4,405	1919	11,569	451,422
1902	870	7,140	1920	2,892	62,323
1903	1	25			
1904	60	900	Totals	83,094	$2,303,139

MOLYBDENUM.

Bibliography: Report XIV. Bulletin 67. U. S. Bur. of Min., Bulletin 111. Proc. Colo. Sci. Soc., Vol. XI.

Molybdenum is used as an alloy constituent in the steel industry, and in certain forms of electrical apparatus. Included in the latter, is its successful substitution for platinum and platinum-iridium in electric contact-making and breaking devices. In alloys it is used similarly to and in conjunction with chromium, cobalt, iron, manganese, nickel, tungsten, and vanadium. The oxides and the ammonium salt have important chemical uses.

The two principal molybdenum minerals are: the sulphide, molybdenite; and wulfenite, lead molybdate, the former furnishing practically the entire commercial output. Molybdenite is found in or associated with acidic igenous rocks, such as the granites and pegmatites. The chief commercial sources have been New South Wales, Queensland, and Norway, with some also from Canada.

Deposits of disseminated molybdenite are known in several localities in California, and in at least two places it occurs in small masses associated with copper sulphides. In 1916, was recorded the first commercial shipments of molybdenum ore in California.

The 1917 output included some concentrates assaying up to 58% MoS_2, but the bulk of it was 1.5% ore which was shipped to Denver, Colorado, for concentration. That production came mainly from Shasta County, with smaller amounts from Inyo, Mono and San Diego counties. There were two concentrating plants built in California—one in each of the above first and last-named counties.

In 1917 the plant of the Sacramento Mining Company, lessee, at the Bour mine near Ramona, San Diego County, made a small output of concentrates; but the mine has since reverted to the owner, and the plant been dismantled.

In the spring of 1918, a flotation plant operated for a short time by a lessee on the Boulder Creek mine, near Gibson Siding, Shasta County, made a small amount of 90% MoS_2 concentrate. The ore treated carried 2.6% MoS_2. There was none produced in 1919, nor 1920.

The California production of molybdenum ore by years is summarized in the following tabulation:

Year	Tons	Value
1916	8	$9,945
1917	243	9,014
1918	*	*
Totals	251	$18,959

*Concealed under 'Unapportioned.'

NICKEL.

Bibliography: Report XIV. U. S. G. S., Bulletin 640-D.

Nickel occurs in the Friday Copper Mine in the Julian District, San Diego County. The ore is a nickel-bearing pyrrhotite, with some associated chalcopyrite. Some ore has been mined during recent years in the course of development work, but not treated nor disposed of, as they are as yet unable to get any smelter to handle it for them. Nickel ore has also been reported from Siskiyou County, west of Gazelle and from San Bernardino County.

OSMIUM (see under Platinum).

PALLADIUM (see under Platinum).

PLATINUM.

Bibliography: State Mineralogist Reports IV, VIII, IX, XII, XIII, XIV, XV. Bulletins 38, 45, 67, 85. U. S. G. S., Bull. 285.

In California platinum is obtained as a by-product from placer operations for gold. The major portion of it comes from the dredges operating in Butte, Calaveras, Sacramento and Yuba counties, while the hydraulic and surface sluicing mines of Del Norte, Humboldt, Siskiyou and Trinity and the dredges of Merced and Stanislaus yield a smaller amount.

The production for 1920 amounted to 679 ounces of crude platinum-group metals, containing 477 fine ounces, valued at $68,977. Of this amount a total of 643 ounces, crude, or 95%, came from the gold

dredges. This is an increase over the 1919 figures. Of this 477 fine ounces, a total of 182 fine ounces was the iridium and osmiridium content. Crude 'platinum' is really a mixture of the metals of that group, and carries varying amounts of platinum, iridium and osmiridium or iridosmine, with occasionally some palladium. Some platinum is also recovered in the electrolytic refining of blister copper. It has been found[1] that blister copper from several smelters in the United States carries from 0.342 oz. to 1.825 oz. platinum and from 0.607 oz. to 4.402 oz. palladium per 100 tons of blister copper treated. That from Iron Mountain, Shasta County, California, also yields some platinum. Iron in greater or less amount is always alloyed naturally with native platinum, and usually some iridium and osmium.

The presence of platinum has recently been identified in the laboratory of the State Mining Bureau, in association with chromite from Siskiyou County. The occurrence of platinum in the Piute mine, near Cima, San Bernardino County, in a lead carbonate ore associated with gold, silver, and copper values, has been confirmed by samples taken by J. M. Hill[2] of the U. S. Geological Survey in 1920 and analyzed in the Survey laboratory. Shipments of this ore were made to a lead smelter in 1919, but apparently the platinum was not recovered.

For further detailed information on California's platinum resources, analyses, tests, et al., the reader is referred to Bulletin 85, recently issued in 1919 by the State Mining Bureau.

In addition, there is usually some platinum recovered as a by-product in the gold refinery of the Mint, but which can not be assigned to the territory of its origin for lack of knowing to which lots of gold it belongs. The San Francisco Mint is stated to have recovered as high as 100 ounces of platinum in a single year from this source, some of which unquestionably came from California mines.

"United States refiners of gold and copper produce annually about 1500 ounces of refined platinum as a by-product, chiefly from copper ore, of both foreign and domestic origin."[3]

[1]Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217-218, 1913.
[2]Personal communication to the author.
[3]Hill, J. M., Our Mineral Supplies. Platinum: U. S. Geol. Surv., Bulletin 666-D.

For 1920, the distribution by counties was as follows:

County	Fine ounces	Value
Butte	42	$4,714
Calaveras	20	2,002
Shasta[2]	158	27,004
Trinity[2]	37	6,612
Yuba	113	14,395
Amador, Mendocino, Plumas, Sacramento, San Joaquin, Stanislaus, Tuolumne*	107	14,250
Totals	477	$68,977

[2]Part of the Shasta and Trinity County product assayed over 50% iridium.
*Combined to conceal output of a single operator in each.

Russia, previous to the war, was producing from 90% to 95% of the world's platinum; but, since 1916 has been reduced to practically nothing.

The price of the metal consequently rose to over $100 per troy fine ounce. During 1916, it varied from $90 in January, to $55 in August, $105 December 1, and closing the year at $82. The 1917 price was from $100 to $105. In 1916, the miners of California received from $43 to $76 per ounce for their crude platinum, and an average of $45.50, as against $29 to $38 per ounce during 1915. In 1917, they received an average of $72 per ounce, and $74.50 in 1918 for crude. During 1918 the U. S. Government commandeered all new platinum produced at a fixed price of $105 per fine ounce. The refiners were licensed and were required to turn over all stocks to the Government. Osmium was quoted at $35 to $40 per ounce, and iridium at $175. Osmiridium is a natural alloy of the two. In 1919, the prices reached $165 per fine ounce for platinum, and $290 per fine ounce for iridium.

In 1920, the average of San Francisco quotations was $114 per fine ounce for platinum, and $149.95 per oz. for platinum containing 10% iridium. The quotations for platinum ranged from $150 in January to $85 in July; then rose to $115 in August, and gradually receded again to $85 in December. For the iridium-bearing, the prices varied from $180 in January to $118 in July, $165 in August, and $125 in December. The quotations in June, 1921, are $75 and $105, respectively. As high as $354 per fine ounce for iridium content was paid in 1920, according to the report of one of the gold dredging companies.

Next in importance to Russia as a producer of platinum is Colombia. California is the leading producer in the United States. As platinum and chromite are alike in their association with serpentine derived from basic igneous rock such as peridotite, pyroxenite and dunite, it is not unlikely that some day platinum will be found in place in

some of California's abundant, chrome-bearing serpentine areas. Platinum and chromite have been found intergrown in dunite on the Tulameen River in British Columbia.[1]

Besides its well-known uses in jewelry, dentistry and for chemical-ware, an important industrial development of recent years employs platinum as a catalyzer in the 'contact process' of manufacturing concentrated sulphuric acid. It is also necessary for certain delicate parts of the ignition systems in automobiles, motor boats, and aeroplanes. Experiments have been made to find alloys which can replace platinum for dishes and crucibles in analytical work, but so far with only slight success.

The annual production and value since 1887, have been as follows:

Year	Ounces	Value	Year	Ounces	Value
1887	100	$400	1905	200	$3,320
1888	500	2,000	1906	91	1,647
1889	500	2,000	1907	300	6,255
1890	600	2,500	1908	706	13,414
1891	100	500	1909	416	10,400
1892	80	440	1910	337	8,386
1893	75	517	1911	511	14,873
1894	106	600	1912	663	19,731
1895	150	900	1913	368	17,738
1896	162	944	1914	463	14,816
1897	150	900	1915	667	21,149
1898	300	1,800	1916	886	42,642
1899	300	1,800	1917	610	43,719
1900	400	2,500	1918	571	42,788
1901	250	3,200	1919	*418	60,611
1902	39	468	1920	477	68,977
1903	70	1,052			
1904	123	1,849	Totals	11,617	$414,836

*Fine ounces.

[1]Kemp, J. F., The geological relations and distribution of platinum and associate metals: U. S. Geol. Surv., Bull. 193, p. 25, Plates II, III, 1902.

QUICKSILVER.

Bibliography: State Mineralogist Reports IV, X, XII, XIII, XIV, XV. Bulletins 27, 78. U. S. G. S., Monograph XIII.

Quicksilver was produced in thirteen counties in 1920, to the amount of 10,278 flasks, valued at $755,527, which is a decrease both in number of flasks and value compared with the year 1919. The average price received during 1920, according to the producers' reports to the State Mining Bureau, was $75.45, as against $89.04 in 1919 and the record price of $114.03 in 1918. The 1920 yield is the smallest number of flasks since 1860.

Prices.

The following table of monthly San Francisco quotations per flask of 75 pounds will indicate the status of quicksilver during the year

1920. San Francisco is the primary domestic market for quicksilver. The 1914 quotations averaged $49.05 per flask. However, because since the war there has been speculation in quicksilver by parties other than the actual producers, and the price changes have often been rapid so that quotations did not always mean sales, we have since 1914 taken for the average value the average actual sales as reported to us by the producers. This gave us an average value of $81.52 per flask for the year 1915, instead of the $85.80 average of quotations; for 1916, $93.50 instead of $125.89; for 1917, $98.29 instead of $106.33; for 1918, $114.03 instead of $117.50; for 1919, $89.04 instead of $90.29, and for 1920, $75.45; instead of $79.70. From this, it will be seen that the speculative element in the quicksilver market has largely disappeared since the close of the war.

San Francisco Quotations of Quicksilver, 1920.

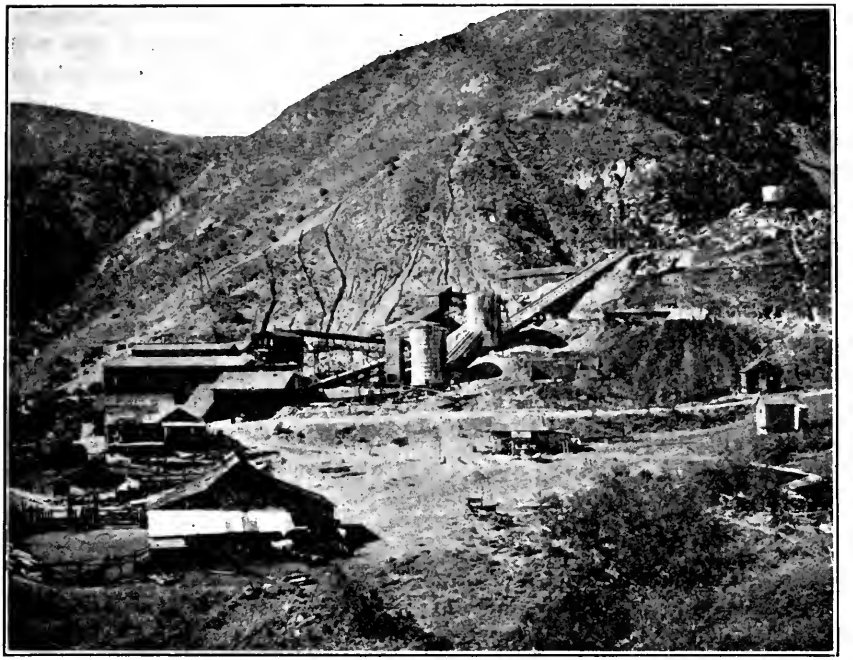
Month	Average price	Month	Average price
January	$89.00	July	$88.00
February	81.00	August	85.00
March	87.00	September	75.00
April	100.00	October	71.00
May	87.00	November	56.00
June	85.00	December	52.50

Present Economic Situation.

The famous mines at Almaden, Spain, are the largest world producers, and are owned by the government. The cost of production of quicksilver is stated to have increased from $8.29 a flask in 1900 to $15.22 in 1915. Their ore is high-grade, the material sent to the furnaces averaging 9%-11% mercury. An interesting account of the Almaden mine has recently been written by Mr. H. W. Gould,[1] formerly General Superintendent of the New Idria mine, California, following a visit to Spain and Italy in January, 1921.

For two or three years previous to the outbreak of the European war, our normal peace-time consumption of quicksilver in the United States was approximately 25,000 flasks annually; and our domestic production had fallen below 20,000 flasks per year. Of this 25,000-flask peace-time consumption, nearly 50% went into the manufacture of fulminate for explosive caps for mining, quarrying, and sporting arms ammunition as well as military ammunition. Our domestic production being inadequate, partly because of the low price and the lower average tenor of the ores mined, necessitated the importation of up to 5000 flasks annually. The enormous increase in munitions manufacture due to the war temporarily raised our requirements correspondingly.

[1]Gould, H. W., The Almaden quicksilver mine in Spain; Min. and Sci. Press, Vol. 122, p. 567, Apr. 23, 1921.



New Idria Quicksilver Mining Company plant, San Benito County, showing reconstruction of condenser system since the fire of June, 1920.

The import duty of 10% *ad valorem* is not sufficient to protect our American miners against the competition of the cheaply-operated mines of Spain and Italy, where quicksilver can be produced for as low as $8 to $15 per flask, as noted above. The duty should be at least $25 per flask to give us proper protection. The new Fordney Tariff Bill, now before Congress, proposes a duty of 35¢ per pound on quicksilver, equivalent to $26.25 per flask.

Quicksilver, though not used in such quantities as is copper or some of the other metals, is not less vital in peace than in war. No completely successful substitute has yet been found for quicksilver in some of its uses. Except during the stimulated production resulting from the high prices of the war period, our domestic output of quicksilver for a number of years has not kept pace with domestic consumption. This is not due to a lack of local sources, but mainly to the competition of low-cost foreign metal dumped onto our market through an almost negligible import duty. Other financial and economic conditions obtaining during the past year have also had their effect on the situation, but they could have been weathered had it not been that the lack of tariff protection permitted the too-free entry of foreign metal. There is plenty of ground, even in California, in addition to what may be in Nevada and Texas, that will warrant development if only a

fair price can be assured that will justify exploitation. Our domestic quicksilver industry is in danger of complete extinction, if not soon given adequate protection against foreign importation. Manufactured mercurials should also be included in the dutiable tariff list, as a protection to our detonator and drug manufacturers, which would in turn further assist the domestic mines. The manufacturers of mercurial products in the United States should join with the miners in the demand for an adequate protective tariff. We should not shortsightedly 'conserve' our domestic quicksilver resources by forcing them to remain in the ground on account of foreign competition, only to wake up some day when faced with an emergency to find that quicksilver mining and metallurgy is a 'lost art' in the United States and cannot be revived at a moment's notice. Several months' time is required to properly equip and put in operation a reduction plant, and the knowledge of the art is even at present confined to a limited few.

Uses.

The most important uses of quicksilver are the recovery of gold and silver by amalgamation, and in the manufacture of fulminate for explosive caps, of drugs, of electric appliances, and of scientific apparatus. By far the greatest consumption is in the manufacture of fulminate and drugs.

One new use for quicksilver is in the introduction of a small amount into the cylinders of steam turbines to improve the vapor pressure and thus increase efficiency. This mercury is recoverable and can be re-used, so that there is only a small proportional loss.

Quicksilver is an absolutely essential element from a military standpoint, as there has not yet been produced an entirely satisfactory commercial substitute for it in the manufacture of fulminating caps for explosives. However, in order to reduce consumption of the fulminate, some potassium chlorate, picric acid, trinitro-tuluol, or tetranitro-methalmine is sometimes mixed with it. The Ordnance Department of the U. S. Army, during the war, at least, would accept no substitutes, as they have thus far proven unreliable.

New Equipment.

The most notable of recent developments in the metallurgy of quicksilver is the adaptation of the rotary cement-kiln to the reduction of quicksilver ore at the New Idria mine, San Benito County. They have there installed five such furnaces, with a combined daily capacity of 500 tons. The lead of the New Idria Company in the matter of rotary furnaces was followed at the Sulphur Bank mine, Lake County; Bella Union or Rutherford mine, Napa County; Cloverdale mine, Sonoma County, and at the January mine, Yolo County.

Operations in 1920.

California operators reported in 1920 that it was costing $65-$75 per flask to produce their metal. With quotations down to $50 per flask, and few sales on account of foreign importations, the California furnaces were all closed down on November 1st, with the exception of the New Almaden, which has continued to operate on a small scale. On June 20th, the reduction plant of the New Idria mine, San Benito County, was wrecked by fire, but they proceeded to rehabilitate it and had two of their five rotary furnaces again in use when compelled to close on account of the above-noted market conditions.

A considerable part of the year's product remained in the warehouse, unsold, at the close of December.

Production.

Though some domestic yield of this metal is now obtained from Texas, Nevada, Arizona, and Oregon, the bulk of the output still comes from California.

The distribution of the 1920 product, by counties, was:

County	Flasks	Value
Kings	436	$28,620
Lake	385	24,314
Napa	266	18,588
San Benito	3,887	296,942
San Luis Obispo	1,224	89,186
Santa Clara	2,893	233,199
Kern, Santa Barbara, Siskiyou, Solano, Sonoma, Stanislaus, Trinity*	1,187	84,678
Totals	10,278	$775,527

*Combined to conceal output of a single operator in each.

The outlook for 1921 promises a still lower yield of quicksilver. Reports to hand (July, 1921) indicate a production of approximately 1,500 flasks for the first six months, mainly from the New Almaden and Cloverdale mines, the latter operating intermittently.

Total Quicksilver Production of California.

Total amount and value of the quicksilver production of California, as given in available records, is shown in the following tabulation. Though the New Almaden mine in Santa Clara County was first worked in 1824, and has been in practically continuous operation since 1846 (though the yield was small the first two years), there are no available data on the output earlier than 1850. Previous to June, 1904, a 'flask' of quicksilver contained 76½ pounds, but since that date 75 pounds. In compiling this table the following sources of information were used: for 1850–1883, table by J. B. Randol, in Report of State Mineralogist, IV, p. 336; 1883–1893, U. S. Geological Survey reports; 1894 to date, statistical bulletins of the State Mining Bureau; also

State Mining Bureau, Bulletin 27, "Quicksilver Resources of California," 1908, p. 10:

Year	Flasks	Value	Average price per flask	Year	Flasks	Value	Average price per flask
1850	7,723	$768,052	$99 45	1886	29,981	$1,064,326	$35 50
1851	27,779	1,859,248	66 93	1887	33,760	1,430,749	42 38
1852	20,000	1,166,600	58 33	1888	33,250	1,413,125	42 50
1853	22,284	1,235,648	55 45	1889	26,464	1,190,880	45 00
1854	30,004	1,663,722	55 45	1890	22,926	1,203,615	52 50
1855	33,000	1,767,150	53 55	1891	22,904	1,036,406	45 25
1856	30,000	1,549,500	51 65	1892	27,993	1,139,595	40 71
1857	28,204	1,374,381	48 73	1893	30,164	1,108,527	36 75
1858	31,000	1,482,730	47 83	1894	30,416	934,000	30 70
1859	13,000	820,690	63 13	1895	36,104	1,337,131	37 04
1860	10,000	535,500	53 55	1896	30,765	1,075,449	34 96
1861	35,000	1,471,750	42 05	1897	26,691	993,445	37 28
1862	42,600	1,526,700	36 35	1898	31,092	1,188,626	38 23
1863	40,531	1,705,544	42 08	1899	29,454	1,405,045	47 70
1864	47,489	2,179,745	45 90	1900	26,317	1,182,786	44 94
1865	53,000	2,432,700	45 90	1901	26,720	1,285,014	48 46
1866	46,550	2,473,202	53 13	1902	29,552	1,276,524	43 20
1867	47,000	2,157,300	45 90	1903	32,094	1,335,954	42 25
1868	47,728	2,190,715	45 90	1904	*28,876	1,086,323	37 62
1869	33,811	1,551,925	45 90	1905	24,655	886,081	35 94
1870	30,077	1,725,818	57 38	1906	19,516	712,334	36 50
1871	31,686	1,999,387	63 10	1907	17,379	663,178	38 16
1872	31,621	2,084,773	65 93	1908	18,039	763,520	42 33
1873	27,642	2,220,482	80 33	1909	16,217	773,788	47 71
1874	27,756	2,919,376	105 18	1910	17,665	799,002	45 23
1875	50,250	4,228,538	84 15	1911	19,109	879,205	46 01
1876	75,074	3,303,256	44 00	1912	20,600	866,024	42 04
1877	79,396	2,961,471	37 30	1913	15,661	630,042	40 23
1878	63,880	2,101,652	32 90	1914	11,373	557,846	49 05
1879	73,684	2,194,674	29 85	1915	14,199	1,157,449	81 52
1880	59,926	1,857,706	31 00	1916	21,427	2,003,425	93 50
1881	60,851	1,815,185	29 83	1917	24,382	2,396,466	98 29
1882	52,732	1,488,624	28 23	1918	22,621	2,579,472	114 03
1883	46,725	1,343,344	28 75	1919	15,200	1,353,381	89 04
1884	31,913	973,347	30 50	1920	10,278	775,527	75 45
1885	32,073	986,245	30 75				
				Totals	2,185,827	$106,700,940	

*Flasks of 75 lbs. since June, 1904; of 76½ lbs. previously.

SILVER.

Bibliography: State Mineralogist Reports IV, VIII, XII, XIII, XIV, XV. Bulletin 67. Min. & Sci. Press, March 1, 1919.

Silver in California is produced largely as a by-product from its association with copper, lead, zinc, and gold ores. As explained under the heading of Gold, the State Mining Bureau does not collect the statistics of silver production independently of the U. S. Geological Survey.

The average price of silver during 1920 was $1.09 per ounce at New York as compared with 54.8¢ in 1914; 50.7¢ in 1915; 65.8¢ in 1916; 82.4¢ in 1917; $1 in 1918; and $1.12 in 1919.

The following paragraph is quoted from the U. S. G. S. Advance Chapter on 1920, by courtesy of Mr. Chas. G. Yale:

"The total production of silver in California in 1920 was 1,706,327 fine ounces, valued at $1,859,896, which is an increase of 599,138 ounces in quantity and $619,845 in value. The deep-mine silver yield was 1,676,427 ounces, valued at $1,827,305 and that from placers was 29,900 ounces, valued at $32,591. The siliceous ores yielded 1,243,971 fine ounces, of which 1,123,451 ounces were from strictly silver ores, as compared with 48,494 ounces from silver ores in 1919. This is an increase of 696,430 ounces from siliceous ores in 1920, as compared with 1919. The copper ores yielded 179,752 fine ounces in 1920, or 169,728 ounces less than 1919. Silver from lead ores in 1920 amounted to 252,704 fine ounces, or 80,495 more than in 1919. The largest output of silver in 1920 was made by San Bernardino County, which produced 1,098,903 fine ounces from siliceous ores, and 13,929 ounces from lead ores, a total of 1,112,832 ounces, valued at $1,212,987. Inyo County produced 10,595 ounces from siliceous ores, 107 ounces from copper ores, and 226,847 ounces from lead ores, a total of 237,549 ounces, valued at $258,929. Plumas County produced 504 ounces from siliceous ores and 139,184 ounces from copper ores, a total of 139,688 fine ounces, valued at $152,260. In all other counties smaller quantities of silver were produced. Shasta for many years the leading producer of this metal only showing an output of 33,544 ounces, valued at $36,563 (including placer) in 1920. The increase of silver in California in 1920 may be attributed to the very large output of the California Rand Silver (Inc.) property in San Bernardino County, a mine producing silver ore with some go'd. There were 18 mines virtually producing silver only in that county in 1920."

The silver output is sustained and encouraged through the operation of the Pitman Act maintaining the price of domestic silver at $1.00 per ounce. The following statement from the mid-year review by Yale[1] shows a continuance of improvement in the California silver yield for 1921:

"The silver received during the first half of 1921 by the mint, smelters, and refineries amounted to 1,235,820 ounces, or 726,535 ounces more than in the first half of 1920, and the first half of 1920 showed an increase of 376,310 ounces over the same period in 1919. This is somewhat remarkable, for several of the large copper mines of the State, from which most of the silver produced in California has usually been derived, have remained closed in 1920 and 1921. The deficiency thus caused has been more than made up during the last two years by the silver and silver-lead mines, more of which have been produced than in the preceding 25 years or more. Most of these mines are in Inyo and San Bernardino counties. By far the largest producer of silver in the State is the Rand, in San Bernardino County, opened in 1919."

The distribution of the 1920 silver yield, by counties, was as follows:

County	Value	County	Value
Amador	$19,780	Plumas	$152,373
Butte	2,253	Sacramento	4,534
Calaveras	16,701	San Bernardino	1,212,987
El Dorado	155	Shasta	36,563
Fresno	227	Sierra	3,967
Humboldt	19	Siskiyou	5,218
Imperial	2,183	Stanislaus	775
Inyo	258,929	Trinity	3,469
Kern	8,385	Tuolumne	6,007
Madera	1,488	Yuba	16,502
Mariposa	4,705	Alpine, Los Angeles, Modoc, San Joaquin*	390
Mono	34,369		
Nevada	58,476		
Orange	7,263	Total	$1,859,896
Placer	2,178		

*Combined to conceal output of a single operator in each.

[1]Yale, C. G., U. S. G. S., Press Bulletin, July 31, 1921.

The value of the silver produced in California each year since 1880 has been as follows, the data previous to 1887 being taken from the reports of the Director of the Mint:

Year	Value	Year	Value
1880	$1,140,556	1901	[2]$571,849
1881	750,000	1902	616,412
1882	845,000	1903	517,444
1883	1,460,000	1904	873,525
1884	[1]4,185,101	1905	678,494
1885	2,568,036	1906	817,330
1886	1,610,626	1907	751,646
1887	1,632,004	1908	873,057
1888	1,700,000	1909	1,091,092
1889	1,065,281	1910	993,646
1890	1,060,613	1911	673,336
1891	953,157	1912	799,584
1892	463,602	1913	832,553
1893	537,158	1914	813,938
1894	297,332	1915	851,129
1895	599,790	1916	1,687,345
1896	422,464	1917	1,462,955
1897	452,789	1918	1,427,861
1898	414,055	1919	1,240,051
1899	504,012	1920	1,859,896
1900	[2]724,500	Total	$42,819,719

[1]Lawver, A. M., in Production of Precious Metals in United States: Report of Director of Mint, 1884, p. 175; 1885.

[2]Recalculated to 'commercial' from 'coining value,' as originally published.

TIN.

Bibliography: Report XV. Bulletin 67.

Tin is not at present produced in California; but during 1891-1892, there was some output from a small deposit near Corona, in Riverside County, as tabulated below. Small quantities of stream tin have been found in some of the placer workings in northern California, but never in paying amounts.

Two occurrences have also been noted, in northern San Diego County. Crystals of cassiterite were found there, associated with blue tourmaline crystals, amblygonite and beryl. No commercial quantity has been developed, only small pockets having been taken out, as yet.

The principal sources of the world's supply of tin are the islands of Banka, Billiton and Singkep, Netherlands India (Dutch East Indies), followed by the Federated Malay States (Perak, Pahang, Negri Sembilan and Selangor). Bolivia, Siam, Cornwall, Transvaal, New South Wales, Queensland and Tasmania are also important sources. A measurable amount of the metal is also recovered by de-tinning scrap and old cans.

Total output of tin in California:

Year	Pounds	Value
1891	125,289	$27,564
1892	126,000	32,400
Totals	251,289	$59,964

TUNGSTEN.

Bibliography: Report on San Bernardino County, 1917; Report XV. Bulletins 38, 67. U. S. G. S., Bull. 652. Proc. Colo. Sci. Soc., Vol. XI. South Dakota School of Mines, Bulletin No. 12.

The metal, tungsten, is used mainly in the steel industry and in the manufacture of electrical appliances, including the well-known tungsten filament lamps. Because of its resistance to corrosion by acids, it is valuable in making certain forms of chemical apparatus. Its employment in tool-steel alloys, permits the operation of cutting tools, such as in lathe work, at a speed and temperature at which carbon steel would lose its temper—hence the name 'high-speed' steels for these tungsten alloys. As made in the United States, tungsten forms 13% to 20% of such steels. Some chromium, nickel, cobalt, or vanadium, are sometimes also included.

Tungsten is introduced into the molten steel charge, either as the powdered metal or as ferro-tungsten (containing 50%-85% tungsten). The specific gravity of the pure metal, 19.3-21.4, is exceeded only by platinum, 21.5; iridium, 22.4; and osmium, 22.5. Its melting point is 3,267° C. (5,913° F.), being higher than any other known metal. Though millions of tungsten filament lamps are now made, the wires are so fine that the metal they contain represents but a few tons of tungsten concentrates annually.

Tungsten ore has been produced in California principally in the Atolia-Randsburg district in San Bernardino and Kern counties, followed by the Bishop district in Inyo County, with small amounts coming from Nevada County and from the district near Goffs, in eastern San Bernardino. Most of the California tungsten ore is scheelite (calcium tungstate), though wolframite (iron-manganese tungstate) and hübnerite (manganese tungstate) also occur. The deposits at Atolia are the largest and most productive scheelite deposits known,[1] and the output has in some years equaled or exceeded that of ferberite (iron tungstate) from Boulder County, Colorado. It is interesting in this connection to note that, in practically all other tungsten producing districts of the world, wolframite is the important constituent. Burma, the largest producer, reported[2] for 1917-1919, yields of 4,537, 4,443, and 3,577 tons of wolframite concentrates, respectively, most of which was obtained from placers, part associated with cassiterite (tin oxide).

Imports of foreign tungsten ores into the United States during 1920 amounted to 1,740 long tons, valued at $779,593, compared with 8,400 long tons, at $6,261,190, in 1919, and 10,362 long tons valued at

[1] U. S. G. S., Bull. 652, p. 32.
[2] U. S. Commerce Reports, No. 78, April 5, 1921, p. 95.

$11,409,237 in 1918, which ores are duty free. Owing to lack of protection against the cheap coolie labor of Asiatic tungsten mines, and the present low market prices, practically all of the tungsten mines in the United States have been closed down since the middle of 1919. Besides the ore, 1,997,719 pounds of tungsten and ferro-tungsten was imported, equivalent to about 2,250 short tons of 60% ore, and probably more than enough to supply the needs of the high-speed tool industry, so that there was added to the already large stock in this country somewhat more than the quantity of tungsten represented by the imports of ore. Though exact figures are not at hand, it is stated that a large quantity of tungsten ore is in stock in this country, probably more than a three years' supply at the average consumption before the World War.

The value of the ore is based upon the content of tungstic trioxide (WO_3), and quotations are commonly made per unit (each 1%) of WO_3 present.

In California in 1920, there was no production of tungsten, neither of ore nor concentrates, for the first time since the beginning of tungsten mining in this state. The market prices quoted during 1920 ranged around $3 per unit. The tonnages here shown are recalculated to a basis of 60% WO_3. Concentrates usually carry 59% to 63%. Previous to 1915, a single company produced almost all of California's tungsten. During the latter part of 1915, and the early months of 1916, because of the high prices prevailing, prospecting was much stimulated, and the known tungsten-bearing areas have been considerably extended both in San Bernardino and Kern counties. Some shipments were made from mines opened up in the Clark Mountain and New York Mountains districts in eastern San Bernardino County. In these latter areas, wolframite and hübnerite are the principal ores, with some scheelite, while at Atolia it is scheelite only. Scheelite ore is also extracted in Inyo County near Bishop, and three concentrating mills have been in operation there. The Nevada County ore is also scheelite.

The annual amount and value of tungsten produced in California since the inception of the industry is given herewith, with tonnages recalculated to 60% WO_3:

Year	Tons at 60% WO_3	Value	Year	Tons at 60% WO_3	Value
1905	57	$18,800	1914	420	$180,575
1906	485	189,100	1915	962	1,005,467
1907	287	120,587	1916	2,270	4,571,521
1908	105	37,750	1917	2,466	3,079,013
1909	577	190,500	1918	1,982	2,832,222
1910	457	208,245	1919	214	219,316
1911	387	127,706	1920	----------	----------
1912	572	206,000			
1913	559	234,673	Totals	11,800	$13,221,475

VANADIUM.

Bibliography: Report XV. Bulletin 67. Proc. Colo. Sci. Soc., Vol. XI. U. S. Bur. of Mines, Bulletin 104.

No commercial production of vanadium has as yet been made in California. Occurrences of this metal have been found at Camp Signal, near Goffs, in San Bernardino County, and two companies have done considerable development work in the endeavor to open up paying quantities. Each had a mill under construction in 1916, but apparently no commercial output was made. Ore carrying the mineral cuprodescloizite and reported as assaying 4% V_2O_5 was opened up. Late in 1917, some ore carrying lead vanadate was discovered in the 29 Palms, or Washington district, on the line between Riverside and San Bernardino counties. Vanadium has also been reported near Lotus in El Dorado County. There is a growing demand for vanadium, for use in the steel industry.

Present quotations for vanadium ore are $1 per pound of V_2O_5 content (guaranteed minimum, 18%); and for ferro-vanadium, $4.25–$4.50 per pound of V shown by analysis.

ZINC.

Bibliography: Reports XIV, XV. Bulletins 38, 67.

During 1920, zinc was produced by one mine, each, in Inyo and Shasta counties to the amount of 1,188,009 pounds, valued at $96,229. This is less than that of 1919, both in tonnage and value, due to the low prices prevailing. The average price for the year was 8.1¢ per pound, as compared to 5.1¢ during 1914; 14.2¢ in 1915; 13.4¢ in 1916; 10.2¢ in 1917; 9.1¢ in 1918, and 7.3¢ in 1919, showing a steady decline from the high-level prices of 1915.

The zinc ores of Shasta County are associated with copper, while those of Inyo and San Bernardino are associated principally with lead-silver ores. The electrolytic zinc plant of the Mammoth Copper Company at Kennett, with a capacity of 100 tons of spelter per month, was in operation during 1918, but has since closed down. It treated bag-house fume. The Mammoth did not ship nor treat any raw zinc ores during 1918–1920. A zinc oxide plant has been built at the Bully Hill mine, Shasta County, and is now (June, 1921) in operation, turning out 30 tons of oxide per day. The ore is treated in roasters, where the zinc is volatilized, then caught in a bag-house containing 1400 woolen bags. The copper, silver and gold in the residues are collected in a matte by reverberatory furnaces.

Total figures for zinc output of the state are as follows, commercial production dating back only to 1906:

Year	Pounds	Value	Year	Pounds	Value
1906	206,000	$12,566	1914	399,641	$20,381
1907	177,759	10,598	1915	13,043,411	1,617,383
1908	54,000	3,544	1916	15,950,565	2,137,375
1909			1917	11,854,804	1,209,190
1910			1918	5,565,561	506,466
1911	2,679,842	152,751	1919	1,384,192	101,046
1912	4,331,391	298,866	1920	1,188,009	96,229
1913	1,157,947	64,845	Totals	57,993,122	$6,231,240

CHAPTER FOUR.

STRUCTURAL MATERIALS.

As indicated by this chapter heading, the mineral substances herein considered are those more or less directly used in building and structural work. California is independent, so far as these are concerned, and almost any reasonable construction can be made with materials produced in the state. This branch of the mineral industry for 1920 was valued at $29,723,405, as compared with a total value of $16,796,784 for the year 1919, the increase being due to increased activity in all building and construction operations, following the release of war-time restrictions.

Deposits of granite, marble and other building stones are distributed widely throughout this state, and slowly but surely transportation and other facilities are being extended so that the growing demand may be met. The largest single item, cement, has had an interesting record of growth since the inception of the industry in California about 1891. Not until 1904 did the annual value of cement produced reach the million-dollar mark, following which it increased 500% in nine years; though from 1914 to 1918 there was a falling off common to all building materials. The 1920 output established a new high-level mark, both in quantity and value.

Crushed rock production is yearly becoming more worthy of consideration, due to the strides recently taken in the use of concrete, as well as to activity in the building of good roads. Brick, with an average annual output for a number of years worth approximately $2,000,000, had difficulty in holding its own, due to the popularity of cement and concrete. In 1920, however, the sales increased to nearly double the previous record figure of the year 1906. This item will, no doubt, continue to be an important one, and of course a market for fire and fancy brick of all kinds will never be lacking.

Fifty-four counties contributed to this structural total for 1920, and there is not a county in the state which is not capable of some output of at least one of the materials under this classification.

The following table gives the comparative figures for the amounts and value of structural materials produced in California during the years 1919 and 1920:

Substance	1919		1920		Decrease— Increase+ Value
	Amount	Value	Amount	Value	
Bituminous rock	4,614 tons	$18,537	5,450 tons	$27,825	$9,288+
Brick and tile		3,087,067		5,704,393	2,617,323+
Cement	4,645,289 bbls.	8,591,990	6,709,160 bbls.	14,962,945	6,370,955+
Chromite	4,314 tons	97,164	1,770 tons	43,031	54,133—
Granite		220,743		495,732	274,989+
Lime	420,696 bbls.	552,043	463,144 bbls.	557,232	5,189+
Magnesite	44,696 tons	452,091	83,695 tons	1,033,491	581,397+
Marble	25,020 cu. ft	74,482	29,531 cu. ft.	92,899	18,417+
Sandstone	5,400 cu. ft.	3,720	10,500 cu. ft.	2,300	1,420—
Miscellaneous stone		3,693,944		6,803,557	3,104,613+
Total value		$16,796,784		$29,723,405	
Net increase					$12,926,621+

ASPHALT.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 16, 32.

Asphalt was for a number of years accounted for in reports by the State Mining Bureau, because in the early days of the oil industry, considerable asphalt was produced from outcroppings of oil sand, and was a separate industry from the production of oil itself. However, at the present time most of the asphalt comes from the oil refineries, which produce a better and more uniform grade; hence, its value is not now included in the mineral total, as to do so would be a partial duplication of the crude petroleum figures. Such natural asphalt as is at present mined is in the form of bituminous sandstones, and is recorded under that designation.

According to the U. S. Geological Survey, the war stimulated activity in the domestic markets for asphaltic materials derived from crude petroleum and for imported asphalt, but relative abundance and adaptability of those materials has lessened the demand for the native bitumens and for the various types of bituminous rock produced in this country.

The production of refinery asphalt, from 16 refineries in California, amounted to 256,000 tons, in 1920, worth approximately $2,500,000. This is a slight increase over the average for several years past. California leads all other states of the Union in such production, as her crude oils are almost entirely of asphaltic base.

BITUMINOUS ROCK.

Bibliography: State Mineralogist Reports XII, XIII, XV.

The manufacture of asphalt at the oil refineries has almost eliminated the industry of mining bituminous rock, but small amounts of the latter are still used occasionally for road dressing. The production during 1920 from quarries in Santa Cruz and Santa Barbara counties was 5,450 tons, valued at $27,825, compared with 4,614 tons and $18,537 in 1919.

The following tabulation shows the total amount and value of bituminous rock quarried and sold in California, from the records compiled by the State Mining Bureau, annually since 1887:

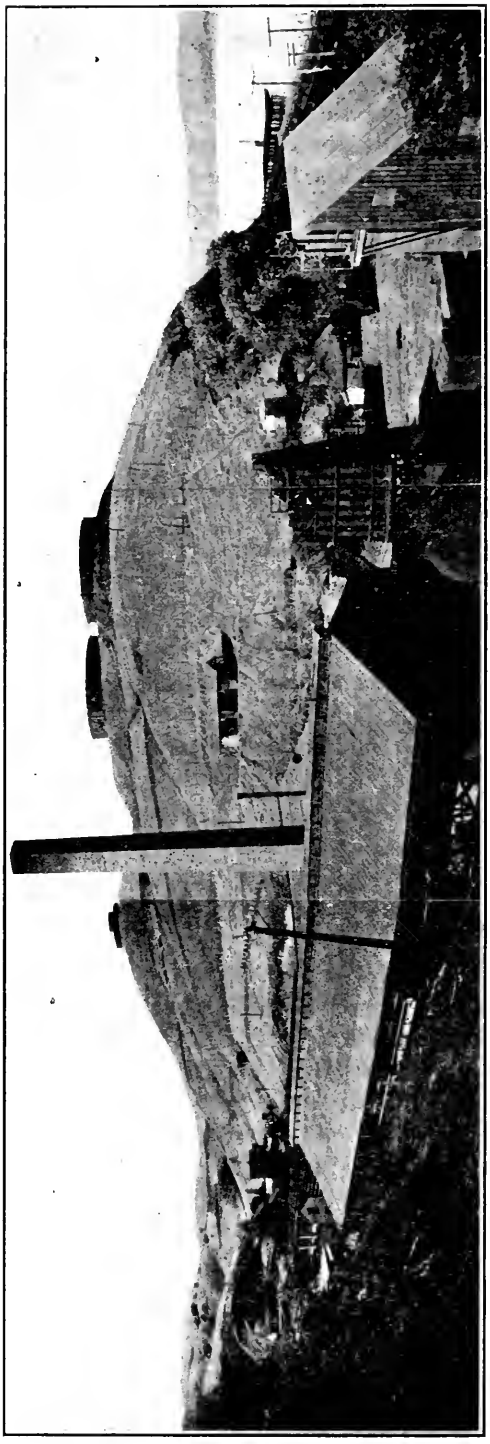
Year	Tons	Value	Year	Tons	Value
1887	36,000	$160,000	1905	24,753	$60,436
1888	50,000	257,000	1906	16,077	45,204
1889	40,000	170,000	1907	24,122	72,835
1890	40,000	170,000	1908	30,718	109,818
1891	39,962	154,164	1909	34,123	116,436
1892	24,000	72,000	1910	87,547	165,711
1893	32,000	192,036	1911	75,125	117,279
1894	31,214	115,193	1912	44,073	87,467
1895	38,921	121,586	1913	37,541	78,479
1896	49,456	122,500	1914	66,119	166,618
1897	45,470	128,173	1915	17,783	61,468
1898	46,836	137,575	1916	19,419	66,561
1899	40,321	116,097	1917	5,590	13,586
1900	25,306	71,495	1918	2,561	9,067
1901	24,052	66,354	1919	4,614	18,537
1902	33,490	43,411	1920	5,450	27,825
1903	21,944	53,106			
1904	45,280	175,680	Totals	1,159,903	$3,548,691

BRICK and TILE.

Bibliography: Reports XIV, XV. Bulletin 38. Preliminary Report, No. 7.

As would be expected in a state with diversified and widespread mineral resources, a great variety of brick is annually produced in California, including common, fire, pressed, glazed, sand-lime, and others. As far as possible the different kinds have been segregated in the following tabulation. We also include under this heading the various forms of hollow building 'tile' or blocks, instead of under industrial pottery clays as in the reports previous to 1915.

The clay industries throughout the country were adversely affected by the war-time restrictions on building operations, and particularly during 1918 by a 50% cut in their fuel and power allowances by the Federal Fuel Administrator. That they have largely recovered from that condition, is shown by comparison of the 1919 and 1920 figures with those of previous years. The total value of the 1920 product is nearly double the previous record figure of the year 1906.



Port Costa Brick Works, Port Costa, Contra Costa County. Drying racks and clay pit are at left.

The detailed figures of brick and tile production for 1920, by counties, are given in the following tabulation:

BRICK AND TILE PRODUCTION FOR 1920, BY COUNTIES.

County	Common		Fire		Glazed, pressed, fancy, vitrified		Hollow building tile or blocks		Total value
	Amount M	Value	Amount M	Value	Amount M	Value	Tons	Value	
Alameda	9,146	$136,053			2,581	$80,548			$216,601
Contra Costa	10,913	159,769	[a]374	51,588	2,321	101,041			312,398
Fresno	12,517	196,756							196,756
Kern	3,850	56,550							56,550
Los Angeles	111,870	1,558,262	[b]9,757	451,941	[c]6,227	323,738	27,954	$308,476	2,642,417
Riverside			11,838	265,677			24,612	214,404	480,081
Santa Clara	11,890	164,680							164,680
Humboldt, Imperial, Marin, Orange, Riverside, Sacramento, San Diego, San Joaquin, Santa Barbara, Shasta, Tulare*	37,734	482,141							
Alameda, Amador, Placer, San Joaquin, Tulare[a]*			13,047	646,421					
Placer, Riverside*					1,777	63,747			
Alameda, Fresno, Placer, Sacramento, San Diego*							46,642	442,601	1,634,910
Totals	197,920	$2,754,211	35,016	$1,415,627	12,906	$569,074	99,208	$965,481	$5,704,393

*Combined to conceal output of a single operator in each.
[a]Includes chrome and magnesite refractory brick.
[b]Includes silica brick and refractories.
[c]Includes vitrified sewer blocks.

Record of brick production in the state has been kept since 1893 by this Bureau, the figures for building tile being also included since 1914. The annual and total figures, for amount and value, are given in the following table:

Year	Brick. M.	Building blocks, tons	Value
1893	103,900		$801,750
1894	81,675		457,125
1895	131,772		672,360
1896	24,000		524,740
1897	97,468		563,240
1898	100,102		571,362
1899	125,950		754,730
1900	137,191		905,210
1901	130,766		860,488
1902	169,851		1,306,215
1903	214,403		1,999,546
1904	281,750		1,994,740
1905	286,618		2,273,786
1906	277,762		2,538,848
1907	362,167		3,438,951
1908	332,872		2,566,495
1909	333,846		3,059,929
1910	340,883		2,934,731
1911	327,474		2,638,121
1912	337,233		2,940,290
1913	358,754		2,915,350
1914	270,791		2,288,227
1915	180,538		1,678,756
1916	206,960		2,096,570
1917	192,269	29,348	2,532,721
1918	136,374	34,818	2,363,481
1919	156,328	36,026	3,087,067
1920	245,842	99,208	5,704,393
Totals	5,945,539	199,400	$56,409,222

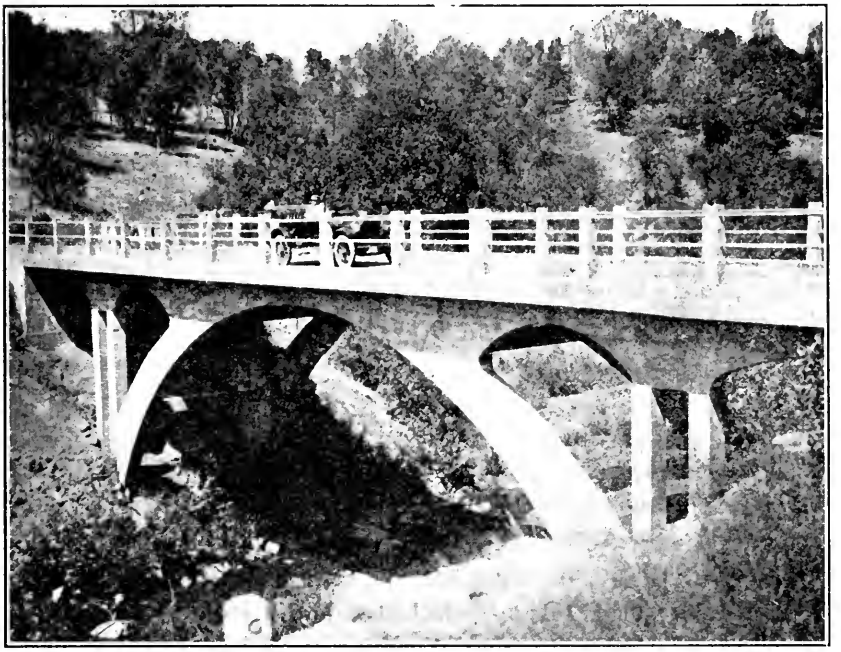
CEMENT.

Bibliography: State Mineralogist Reports VIII, IX, XII, XIV, XV. Bulletin 38.

Cement is one of the most important structural materials in the output of the state. During 1920 there was produced a total of 6,709,160 barrels, valued at $14,962,945, being a 50 per cent increase in quantity, and a 70 per cent increase in value, over the 1919 figures. This exceeds, both in quantity and value, the record production of 1911. This output comes from nine operating plants in seven counties. The features of the 1920 production are the increased average price, per barrel, and the return to the operating list of the Monolith plant, in Kern County. This plant, owned by the City of Los Angeles, is under lease to the United States Potash Company. The average value, reported, increased from $1.85 per barrel, in 1919, to $2.23 in 1920.

Several of the cement plants have recovered potash-bearing materials as by-products, notably: The Riverside Portland Cement Company, Riverside County; California Portland Cement Company, and Southwestern Portland Cement Company, San Bernardino County; Santa Cruz Portland Cement Company, Santa Cruz County. The first-named was the pioneer in this work.

The cement industry is so centralized that it is not possible to apportion the production to the counties in which plants are located without



Concrete bridge on the State Highway near Placerville, California.

making private business public. With the exception of San Bernardino, no county has more than one cement plant. The three operating plants in San Bernardino County, in 1920, made a total of 1,681,283 barrels, valued at $3,051,079; the balance coming from a single plant in each of the following counties: Contra Costa, Kern, Riverside, San Benito, Santa Cruz and Solano.

'Portland' cement was first commercially produced in the state in 1891; though in 1860 and for several years following, a natural hydraulic cement from Benicia was utilized in building operations in San Francisco. While the total figures are not of the same magnitude as those for gold and petroleum, the growth of the industry has been more than rapid, and a comparison of the annual figures representing the output since the inception of the industry is of interest. It may be

noted, however, that the value of California cement for 1920 exceeded the value of the gold output for the same period.

According to reports of the U. S. Geological Survey, California ranked third as a cement producer in 1920, being surpassed by Pennsylvania with 28,365,000 barrels, and Indiana with 10,700,000 barrels.

Annual production of cement in California has been as follows:

Year	Barrels	Value	Year	Barrels	Value
1891	5,000	$15,000	1907	1,613,563	$2,585,577
1892	5,000	15,000	1908	1,629,615	2,359,692
1893			1909	3,779,205	4,969,437
1894	8,000	21,600	1910	5,453,193	7,485,715
1895	16,383	32,556	1911	6,371,369	9,085,625
1896	9,500	28,250	1912	6,198,634	6,074,661
1897	18,000	66,000	1913	6,167,806	7,743,024
1898	50,000	150,000	1914	5,109,218	6,558,148
1899	60,000	180,000	1915	4,918,275	6,044,950
1900	52,000	121,000	1916	5,299,507	6,210,293
1901	71,860	159,842	1917	5,790,734	7,544,282
1902	171,000	423,600	1918	4,772,921	7,969,909
1903	640,868	968,727	1919	4,645,289	8,591,990
1904	969,538	1,539,807	1920	6,709,160	14,962,945
1905	1,265,553	1,791,916			
1906	1,286,000	1,941,250	Totals	73,087,131	$105,640,796

CHROMITE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV, XV. Bulletins 38, 76. Preliminary Report 3, U. S. G. S., Bull. 430. Min. & Sci. Press, Vol. 114, p. 552.

Chromic iron ore, or chromite, to the amount of 1668 short tons of all grades (or 1770 tons, recalculated to a basis of 45% Cr_2O_3), valued at $43,031 f. o. b. shipping point, was sold in California during the year 1920. There are still on the ground, mined in 1918 but not sold, various lots of ore throughout the chrome districts of the state, aggregating several thousand tons, which have not been shipped owing to the radical drop in price and demand, following the close of the war late in 1918. The above amount sold in 1920 is but a fraction of the 73,955 tons of all grades, valued at $3,649,497 shipped in 1918, and less than one-half of the 1919 figure. There were 24 shippers, or producers, in 1919, as compared with 236 in 1918, who shipped, individually, amounts varying from a few tons to 6000 tons. In 1920, there were but 13 shippers, in seven counties.

Chromite is widely distributed in California, the principal production, thus far, having come from El Dorado, San Luis Obispo, Del Norte, Shasta, Siskiyou, Placer, Fresno, and Tuolumne counties. In 1918 a total of 29 counties contributed to the state's output.

Economic Conditions.

Chromite is one of several of California's minerals most affected by the economic conditions brought about by the European war. The major portion of our domestic requirements for chrome is for consumption in the steel mills of the East. Formerly, most of that used was imported from Rhodesia and New Caledonia, and they are still, with the addition of India, the more important sources. The reports of the U. S. Department of Commerce show the foreign imports of chromic iron for the seven years 1913–1920 (inc.) to have been 49,772; 75,455; 115,886; 72,063; 100,142; 61,404 and 150,275 long tons, respectively. The average price of imports in 1920 was $12.85 per ton. Similarly to conditions discussed herein under manganese (see *ante*), the increased demand for steel products also increased the necessity for chromite as a refractory and for the preparation of ferro-chrome. Our own domestic sources supplied a part of the increased demand.

According to Dolbear,[1]

"to be readily salable chrome ore should contain at least 40% chromic oxide (Cr_2O_3) and less than 8% silica (SiO_2). Some ore is sold which carries not more than 30% Cr_2O_3; sometimes SiO_2 as high as 10% to 15% is permitted. Ore containing 40% Cr_2O_3 is more satisfactory in fire brick manufacture than 30% or 50% ore. When other grades are purchased they are sometimes crushed and mixed with higher or lower grades, as may be required, to secure a 40% product."

The major consumption of chromic ore is for its use as a refractory lining in smelting furnaces for steel and copper. A smaller portion is used in the preparation of ferro-chrome for chrome-steel alloys. Some of the California product in 1916–1918 was converted into ferro-chrome in the electric furnaces of the Noble Electric Steel Company at Heroult, Cal., and some of it was similarly reduced in electric furnaces at Niagara Falls, N. Y. A small amount of high-grade ore was utilized in preparation of chromates for tanning.

A report, designated as Bulletin No. 76, of the State Mining Bureau, was issued in 1918, giving a detailed account of California's resources in both manganese and chromite.

The War Mineral Relief Commission is still working on the adjustment of claims for chromite mined in 1917–1918, but the law as at present worded is too restricted. An amendment to the Dent Bill (H. R. 13274) has been introduced in Congress to permit of a more liberal interpretation in the consideration of claims.

Occurrence.

Until 1916, when some shipments were made from Oregon and smaller amounts from Maryland, Wyoming and Washington, practically our only domestic production of chromite for many years came from California. From 1820 to 1860 the deposits in Pennsylvania and Maryland

[1]Dolbear, S. H., Min. and Sci. Press, April 21, 1917, p. 554.

supplied the world's consumption. There are two main belts in California yielding this mineral,—one, along the Coast Ranges from San Luis Obispo County to the Oregon line, including the Klamath Mountains at the north end, and the other in the Sierra Nevada from Tulare County to Plumas County. Chromite occurs as lenses in basic igneous rocks such as peridotite and pyroxenite, and in serpentines which have been derived by alteration of such basic rocks. For the most part, so far as developments have yet shown, the lenses have proven to be small, relatively few of them yielding over 100 tons apiece. A notable exception to this was the deposit on Little Castle Creek near Dunsmuir, from which upwards of 15,000 tons was shipped before it was exhausted. Deposits worked in Del Norte County during 1918 promised well for a large tonnage. On the whole the orebodies in the northwestern corner of the state appear to average larger in size than the chromite lenses in other parts of California.

Concentration became an accomplished fact in several localities, thus utilizing some of the disseminated and lower-grade orebodies which have been found. In fact, an important part of the 1918 production came from this source; likewise in 1919–1920.

Prices and Production.

During 1920 the prices in California on the basis of 45% chromic oxide ranged from $20 to $30 per ton f. o. b., with a premium for higher grades and deductions for lower. The producers' reports to the State Mining Bureau indicate an average of approximately $25.70 per ton received for all grades for the year as against $23.50 in 1919; $49.35 in 1918; $21.60 in 1917, and $14.65 in 1916. For the eastern buyer, to these prices freight charges of $11 to $16 per ton, had to be added. For the present year (1921) practically no ore has been moving.

The distribution of the 1920 product, by counties, was as follows, the tonnage being recalculated to 45% Cr_2O_3:

County	Tons	Value
Lake	84	$1,560
Placer	390	7,985
San Luis Obispo	399	10,440
Siskiyou	215	5,732
Del Norte, El Dorado, Mendocino*	682	17,314
Totals	1,770	$43,031

*Combined to conceal output of a single operator in each.

Total Chromite Production of California.

Production of chromite in California began, apparently, about 1874, principally in San Luis Obispo County. There was considerable activity from 1880 to 1883, inclusive, and a total of 23,238 long tons

(or 26,028 short tons), valued at $329,924 was shipped from that county up to the beginning of 1887. Some ore also was shipped from the Tyson properties in Del Norte County. The tabulation herewith shows the output of chromite in California, annually, including the earliest figures so far as they are available. The figures from 1887 to date are from the records of the State Mining Bureau:

Year	Tons	Value	Year	Tons	Value
1874-1886 (San Luis Obispo Co.)	26,028	$329,924	1904	123	$1,845
1887	3,000	40,000	1905	40	600
1888	1,500	20,000	1906	317	2,859
1889	2,000	30,000	1907	302	6,040
1890	3,599	53,985	1908	350	6,195
1891	1,372	20,580	1909	436	5,309
1892	1,500	22,500	1910	749	9,707
1893	3,319	49,785	1911	935	14,197
1894	3,680	39,980	1912	1,270	11,260
1895	1,740	16,795	1913	1,180	12,700
1896	786	7,775	1914	1,517	9,434
1897			1915	3,725	38,044
1898			1916	48,943	717,244
1899			1917	52,379	1,130,298
1900	140	1,400	1918	73,955	3,649,497
1901	130	1,950	1919	*4,314	97,164
1902	315	4,725	1920	1,770	43,031
1903	150	2,250	Totals	241,564	$6,397,623

*Recalculated to 45 per cent Cr_2O_3, beginning with 1919.

GRANITE.

Bibliography: State Mineralogist Reports X, XII, XIII, XIV, XV. Bulletin 38.

In the reports for several years previous to 1916 granite was treated as a subdivision under 'Stone Industry' or under 'Miscellaneous Stone.' We have since rearranged the subjects, somewhat, and now give granite a separate heading, as had previously been done with marble and sandstone. Crushed rock and paving blocks derived from granite quarries are continued under the heading of 'Miscellaneous Stone.'

The output of granite, particularly for building and ornamental purposes, shows a falling off since 1914 from earlier annual amounts. That granite is not used more is probably due to its greater cost as compared to concrete and ornamental brick and tile for buildings. From 1915 to 1919, inclusive, there were no new large pieces of work undertaken. Building operations of all kinds, except those directly connected with war contracts, were largely suspended. The 1920 figures show an increase over those for 1919.

Granite Production, by Counties, for 1920.

County	Building stone		Monumental		Curbing		Unclassified		Total value
	Cubic feet	Value	Cubic feet	Value	Linear feet	Value	Cubic feet	Value	
Fresno			10,900	$49,000					$49,000
Placer							4,602	$12,573	12,573
Riverside	4,700	$3,750	11,658	21,658					25,408
San Diego			2,460	7,838					7,838
Madera and Placer*	29,250	205,938							
Humboldt, Madera, Placer, Plumas, Tulare*			22,480	76,421					
Placer, San Luis Obispo*					2,375	$1,978			
Madera, Nevada, Riverside, San Bernardino[a]*							109,901	116,576	400,913
Totals	33,950	$209,688	47,498	$154,917	2,375	$1,978	114,503	$129,149	$495,732

*Combined to conceal output of a single operator in each.
[a]Includes 'firestone' used for cement-kiln liners.

California building granites, particularly the varieties from Raymond, Madera County, and Rocklin, Placer County, are unexcelled by any similar stone found elsewhere.

Granites of excellent quality for building and monumental purposes are also quarried in Riverside and San Diego counties. The Fresno County stone is a dark, hornblende diorite, locally called 'black granite,' whose color permits of a fine contrast of polished and unpolished surfaces, making it particularly suitable for monumental and decorative purposes. There is also a similar 'black granite' in Tulare County.

In so far as it has been possible to do so, granite production has been segregated in the following table into the various uses to which the product was put. It will be noted, however, that a portion of the output has been entered under the heading 'unclassified.' This is necessary because of the fact that some of the producers have no way of telling to what specific use their stone was put after they had quarried and sold the same in the rough.

The value of granite produced, annually since 1887, has been as follows:

Year	Value	Year	Value
1887	$150,000	1905	$353,837
1888	57,000	1906	344,083
1889	1,329,018	1907	373,376
1890	1,200,000	1908	512,923
1891	1,300,000	1909	376,834
1892	1,000,000	1910	417,898
1893	531,322	1911	355,742
1894	228,816	1912	362,975
1895	224,329	1913	981,277
1896	201,004	1914	628,786
1897	188,024	1915	227,928
1898	147,732	1916	535,339
1899	141,070	1917	221,997
1900	295,772	1918	139,861
1901	519,285	1919	220,743
1902	255,239	1920	495,732
1903	678,670		
1904	467,472	Total	$15,464,084

LIME.

Bibliography: Reports XIV, XV. Bulletin 38.

Lime to the amount of 463,144 barrels, valued at $557,232, was produced by nine plants in seven counties during 1920, as compared with 420,696 barrels, valued at $552,043 in 1919. So far as we have been able to segregate the data, this figure includes only such lime as is used in building operations. That utilized in sugar making, for smelter flux, and as a fertilizer, are classified under 'Industrial

Materials.' That consumed in cement manufacture is included in the value of cement.

Distribution by counties is shown in the following table:

County	Barrels	Value
Kern	76,395	$106,733
Santa Cruz	141,633	202,908
Plumas, San Bernardino, Shasta, Siskiyou, Tuolumne*	245,116	247,591
Totals	463,144	$557,232

*Combined to conceal output of a single operator in each.
For table of production by years, see under 'industrial' limestone, *post.*

In March, 1921, a shipment of 10,000 barrels of lime from Canada, valued at $24,544, was brought into California through the port of San Francisco, the custom's duty being very low. This is unusual, but it is hoped that it will not prove the forerunner of larger consignments to compete with our local industry. California has ample resources of the raw material.

MAGNESITE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38. U. S. G. S., Bulletins 355, 540. Min. & Sci. Press, Vol. 114, p. 237. "Magnesite"—Hearings before the Comm. on Ways and Means, House of Repr. on H. R. 5218, June 16, 17 and July 17, 1919.

Occurrence.

Magnesite is a natural carbonate of magnesium, and when pure contains 52.4% CO_2 (carbon dioxide) and 47.6% MgO (magnesia). It has a hardness of 3.5 to 4.5, and specific gravity of 3 to 3.12. It is both harder and heavier than calcite (calcium carbonate), and also contains a higher percentage of CO_2, as calcite has but 44%.

Most of the California magnesite is comparatively pure, and is ordinarily a beautiful, white, fine-grained rock with a conchoidal fracture resembling a break in porcelain. The Grecian magnesite is largely of this character; while the Austrian varieties usually contain iron so that they become brown after calcining. The Washington magnesite, one of the most recent developments, resembles dolomite and some crystalline limestones in physical appearance. Its color varies through light to dark gray, and pink.

In California, the known deposits are mostly in the metamorphic rocks of the Coast Ranges and Sierra Nevada Mountains, being associated with serpentine areas. The notable exceptions are two sedimentary deposits, one at Bissell in Kern County, and one at Afton in San Bernardino County. Several thousand tons have been shipped

from the Bissell deposit; and small shipments have been made from the Afton property.

The Washington deposits are stated to be associated with extensive strata of dolomitic limestones. The magnesite there appears to contain more iron than most of the California mineral, which makes it desirable for the steel operators. However, the experience of the past four years has proven that several California localities have sufficient iron in their magnesite to be serviceable in the steel furnaces. This is particularly true of the Refractory Magnesite Company's mine near Preston in Sonoma County, and the White Rock Mine at Pope Valley, Napa County.

Uses.

The principal uses at the present time include: refractory linings for basic open-hearth steel furnaces, copper reverberatories and converters, bullion and other metallurgical furnaces; in the manufacture of paper from wood pulp; and in structural work, for flooring, wainscoting, tiling, sanitary kitchen and hospital finishing, etc. In connection with building work, it has proven particularly efficient as a flooring for steel railroad coaches, on account of having greater elasticity and resilience than 'Portland' cement. For refractory purposes, the magnesite is 'dead burned'—*i. e.*, all or practically all of the CO_2 is expelled from it. For cement purposes, it is left 'caustic'—*i. e.*, from 5% to 10% of CO_2 is retained. When dry caustic magnesite is mixed with a solution of magnesium chloride ($MgCl_2$) in proper proportions, a very strong cement is produced, known as oxychloride or Sorel cement. It is applied in a plastic form, which sets in a few hours as a tough, seamless surface.

It is stated that some metallic magnesium has been prepared electrolytically at Niagara Falls, from magnesite (see also Magnesium Chloride, under 'Salines,' *post*).

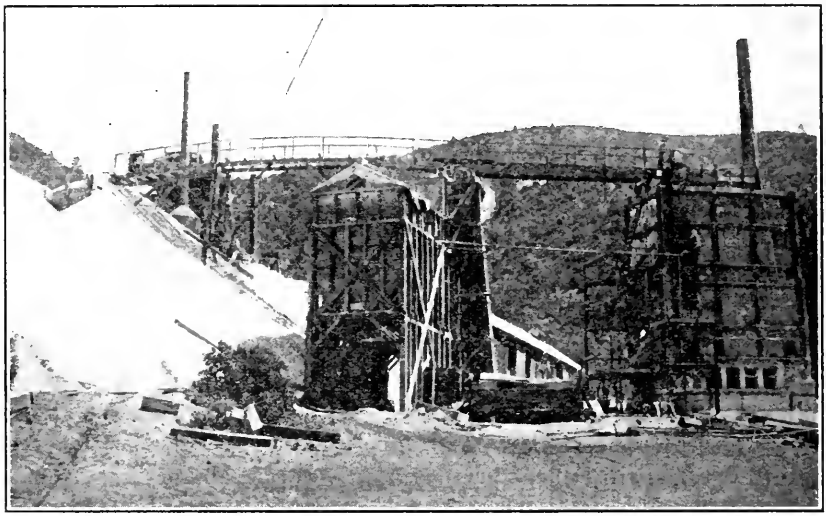
For refractory purposes, the calcined magnesite is largely made up into bricks, similar to fire-brick for furnace linings. It is also used un-consolidated, as 'grain' magnesite. For such, an iron content is desirable, as it allows of a slight sintering in forming the brick. Dead-burned, pure, magnesia cannot be sintered except at very high temperatures; and it has little or no plasticity, so that it is hard to handle. Its plasticity is said to be improved by using with it some partly calcined or caustic magnesite. Heavy pressure will bind the material sufficiently to allow it to be sintered.

A coating of crushed magnesite is laid on hearths used for heating steel stock for rolling, to prevent the scale formed from attacking the fire-brick of the hearth.

Imports, and Domestic Production.

Reports of the U. S. Bureau of Foreign and Domestic Commerce show imports of calcined magnesite to have been 172,591 tons in 1913; 144,747 tons in 1914; and 63,347 tons in 1915; most of it coming from Austria-Hungary. For the same years, the production of crude (about two tons of crude ore required to yield one ton of the calcined) magnesite in California (the sole producer for those years, in the United States) was: 9,632 tons, 1913; 11,438 tons, 1914; 30,721 tons, 1915. For 1916 the California output leaped to 154,052 tons of crude and to 209,648 tons in 1917, but dropped considerably in 1918 and 1919. Shipments were begun from Washington late in 1916.

The Fordney Tariff Bill now before Congress places a duty on magnesite, which it is hoped will enable our domestic mines to operate.



Scott, fine-ore, quicksilver furnace (at right) rebuilt and in use for calcining magnesite fines at Western Magnesite Development Company property, Santa Clara County. Storage bunkers with elevator for calcined fines in center. Four vertical stack kilns at left, for burning lump ore. Photo by courtesy of C. S. Maltby.

Output and Value.

In considering mineral production the value of the crude material is used as far as practicable. Magnesite presents a peculiar example of a material which previous to 1916 was seldom handled on the market in the crude state. It is mainly calcined and ground before being considered marketable. From 2 to $2\frac{1}{2}$ tons of the crude material are mined to make one ton of the calcined. In the earlier reports an arbitrary value for the crude material at the mine was calculated from the above on the basis of the calcined value, there having been very little product shipped crude. On the contrary, however, considerable tonnages since 1916 have been shipped in the crude state, contracted

at prices ranging from $7 to $17 per ton, f.o.b. rail points. The rage was $13.20 per ton, for 1920. This is the basis of the valua- used herein.

The production of crude magnesite in California during the year 20 totaled 83,695 tons, valued at $1,033,491 f.o.b. rail-shipping point. is is nearly double the 1919 output of 44,696 tons and more than ee the value of $452,094.

'ome magnesite has been imported from eastern Canada, which is er to the steel-producing centers. The Canadian magnesite, though taining an objectionable percentage of lime, was used during the r on account of being cheaper and nearer at hand. Importations m Austria have been resumed to a limited extent.

t looks as if the main hope for the future for California magnesite in the development of the plastic business, particularly in the itory west of the Rocky Mountains; and in the manufacture of ractory brick to be utilized mainly by the copper and lead smelters the same district. It is possible that, after ocean shipping has umed its normal routes, California magnesite may be sent via the nama Canal to the Atlantic seaboard; but, on account of our higher oduction costs, it is difficult to see how we can compete with the ecian article at Atlantic ports.

Three plants reported making refractory brick here from California gnesite in 1920, one each at Porterville, Los Angeles, and Richmond. ring 1917–1918, the output of the Refractory Magnesite Company Preston, Sonoma County, was turned into bricks at the plant of the ckton Fire and Enamel Brick Company, at Stockton. The mine s closed in 1919, but reopened in 1920. The mineral from this perty is a natural ferro-magnesite and has found a ready market refractory purposes. That from the White Rock Mine in Napa nty also carries some iron.

"NEEDS FOR STANDARDIZING THE DOMESTIC PRODUCT.[1]

"One of the most important factors in the success of Austrian magnesite has been careful standardization of the finished product attained only by careful selection preparation of the raw material, and skillful burning, whereby a product of form quality has been assured. Uniformity and close adherence to specifications oubtedly have been important factors in the growth of both Austrian and Grecian ness in the United States. These factors are called to the attention of certain of domestic producers because laxity on the part of a few of them in these respects caused some dissatisfaction among certain domestic consumers, and unfortunately unsympathetic attitude toward them, at the present time.

"There were undoubtedly extenuating circumstances during the war period, among ch was the sudden and urgent demand caused by the complete cutting off of the strian and Grecian product, together with a certain degree of inexperience in the ness. The importance to our own producers of careful selection and care in burn- can not be over-emphasized in the building up and maintenance of the domestic ustry, and it is believed that the domestic producers are alive to the situation."

In 1918, for the first time since Tulare County became an important oducer of this mineral, it was surpassed in tonnage output for the

[1] Phalen, W. C., Magnesite. In "Excerpts from monthly reports on minerals investi- ions in the Bureau of Mines, Department of the Interior," February, 1919.

year, but regained the lead in 1919, followed by Santa Clara and Nap counties, respectively. The same ranking was retained in 1920. Th largest individual producer in 1920 was the Western Magnesit Development Co., in Santa Clara County, operated under lease b C. S. Maltby. Approximately 32,000 tons were reported as shippe calcined, representing 64,000 tons of crude ore.

Production of crude magnesite for 1920, by counties, is given in th following table, with total crude value:

County	Tons	Value
Fresno	906	$8,7
Santa Clara	26,612	392,5
Stanislaus	4,064	39,4
Tulare	35,305	394,1
Napa, San Benito, Sonoma*	16,808	198,5
Totals	83,695	$1,033,4

*Combined to conceal output of a single operator in each.

Annual production of magnesite for California, amount and valu since 1887, is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	600	$9,000	1905	3,933	$16,3
1888	600	9,000	1906	4,032	40,3
1889	600	9,000	1907	6,405	57,7
1890	600	9,000	1908	10,582	80,4
1891	1,500	15,000	1909	7,942	62,1
1892	1,500	15,000	1910	16,570	113,9
1893	1,093	10,930	1911	8,858	67,4
1894	1,440	10,240	1912	10,512	165,3
1895	2,200	17,000	1913	9,632	77,1
1896	1,500	11,000	1914	11,438	114,3
1897	1,143	13,671	1915	30,721	283,4
1898	1,263	19,075	1916	154,052	1,311,8
1899	1,280	18,480	1917	209,648	1,976,7
1900	2,252	19,333	1918	83,974	803,2
1901	4,726	43,057	1919	44,696	452,4
1902	2,830	20,655	1920	83,695	1,033,1
1903	1,361	20,515			
1904	2,850	9,298	Totals	726,028	$6,875,5

MARBLE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, X Bulletin 38. U. S. Bur. of M., Bull. 106.

Marble is widely distributed in California, and in a considerab variety of colors and grain. During 1920, the production amount to 29,531 cubic feet, valued at $92,899, from one operator in In County, and two in Tuolumne. This shows a small increase both amount and value from the previous year. This is considerably bel what might be considered the normal output of former years, a certainly far below our possibilities. There are many varieties fou

in California suitable for all purposes of construction or decoration. Among the latter are deposits of onyx marble of beautiful coloring. There is also serpentine marble suitable for electrical switchboard use.

The decrease in output of marble in recent years is probably due in part to the fact that foreign, eastern and Alaskan marbles are landed here by water cheaper than much of our local stone can be put on the market, on account of our higher labor costs and transportation difficulties, though California has many beautiful and serviceable varieties.

In quarry of Columbia Marble Company of Columbia, Tuolumne County, showing channeled faces. Photo by C. A. Logan.

It is also due in part to the general curtailment of building activity during the war period.

Data on annual production since 1887, as compiled by the State Mining Bureau, follows. Previous to 1894 no records of amount were preserved:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887		$5,000	1905	73,303	$129,450
1888		5,000	1906	31,400	75,800
1889		87,030	1907	37,512	118,066
1890		80,000	1908	18,653	47,665
1891		100,000	1909	79,600	238,400
1892		115,000	1910	18,960	50,200
1893		40,000	1911	20,201	54,103
1894	38,441	98,326	1912	27,820	74,120
1895	14,864	56,566	1913	41,654	113,282
1896	7,889	32,415	1914	25,436	48,832
1897	4,102	7,280	1915	22,186	41,518
1898	8,050	23,594	1916	25,954	50,280
1899	9,682	10,550	1917	24,755	62,950
1900	4,103	5,891	1918	*17,428	49,898
1901	2,945	4,630	1919	25,020	74,482
1902	19,305	37,616	1920	[a]29,531	92,899
1903	84,624	97,354			
1904	55,401	94,208	Total value		$2,222,405

*Includes onyx and serpentine.
[a]Includes onyx.

ONYX and TRAVERTINE.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38.

Onyx and travertine are known to exist in a number of places in California, but there has been no production reported since the year 1896, except 1918 and 1920. Some stone was shipped in 1918 and 1920 from the Tolenas Springs onyx marble deposit in Solano County, and utilized for decorative purposes. As there was but a single operator, the figures have been combined with those of the marble output. There are prospects of increased production for 1921, as development work is under way on deposits in Kern and Mono counties.

Production by years was as follows:

Year	Value	Year	Value
1887	$900	1894	$20,000
1888	900	1895	12,000
1889	900	1896	24,000
1890	1,500	1918	*
1891	2,400	1919	*
1892	1,800	1920	*
1893	27,000		
		Total	$91,400

*See under Marble.

SANDSTONE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38. U. S. Bur. of M., Bull. 124.

An unlimited amount of high-grade sandstone is available in California, but the wide use of concrete in buildings of every character, as well as the popularity of a lighter-colored building stone, has curtailed production in this branch of the mineral industry during recent years almost to the vanishing point. In 1920 two counties—Santa Barbara and Ventura—turned out 10,500 cubic feet, valued at $2,300, compared with 5,400 cubic feet and $3,720 in 1919. This is considerably less than former years. The main feature of the loss since 1914 is the closing of the well-known Colusa quarries, on account of the competition of lighter-colored materials.

Amount and value, so far as contained in the records of this Bureau, are presented herewith, with total value from 1887 to date:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887		$175,000	1905	302,813	$483,268
1888		150,000	1906	182,076	164,068
1889		175,598	1907	159,573	148,148
1890		100,000	1908	93,301	55,151
1891		100,000	1909	79,240	37,032
1892		50,000	1910	165,971	80,443
1893		26,314	1911	255,313	127,314
1894		113,592	1912	66,487	22,574
1895		35,373	1913	62,227	27,870
1896		28,379	1914	111,691	45,322
1897		24,086	1915	63,350	8,438
1898		46,384	1916	17,270	10,271
1899	56,264	103,384	1917	31,090	7,074
1900	378,468	254,140	1918	900	400
1901	266,741	192,132	1919	5,400	3,720
1902	212,123	142,506	1920	10,500	2,300
1903	353,002	585,309			
1904	363,487	567,181	Total value		$4,692,771

SERPENTINE.

Bibliography: Report XV. Bulletin 38.

Serpentine has not been produced in California to a very large extent at any time. A single deposit, that on Santa Catalina Island, has yielded the principal output to date. Some material was shipped from there in 1917 and 1918, being the first recorded since 1907. It was used for decorative building purposes and for electrical switchboards. As there was but a single operator, the figures were combined with those of marble output for those years.

The following table shows the amount and value of serpentine from 1895 as recorded by this Bureau:

Year	Cubic feet	Value	Year	Cubic feet	Value
1895	4,000	$4.000	1904	200	$2,310
1896	1,500	6,000	1905		
1897	2,500	2,500	1906	847	1.694
1898	750	3,000	1907	1,000	3,000
1899	500	2,000	1917	[1]	[1]
1900	350	2,000	1918	[2]	[2]
1901	89	890	1919		
1902	512	5,065			
1903	99	800	Totals	12,347	$33,259

[1]Under 'Unapportioned.'
[2]See under Marble.

SLATE.

Bibliography: Report XV. Bulletin 38.

Slate was first produced in California in 1889. Up to and including 1910 such production was continuous, but there has been none since, except in 1915, and a small amount in 1920. Large deposits of excellent quality are known in the state, especially in El Dorado, Calaveras and Mariposa counties, but the demand has been light owing principally to competition of cheaper roofing materials.

A square of roofing slate is a sufficient number of pieces of any size to cover 100 square feet of roof, with allowance generally for a three-inch lap. The size of the pieces of slate making up a square ranges from 7 x 9 inches to 16 x 24 inches, and the number of pieces in a square ranges from 85 to 686. It is worth $3.50 to $10 per square, f.o.b. quarry, depending on quality. The Ferry Building, San Francisco, is roofed with Eureka slate from El Dorado County.

A complete record of amount and value of slate produced in California follows:

Year	Squares	Value	Year	Squares	Value
1889	4,500	$18,089	1903	10,000	$70,000
1890	4,000	24,000	1904	6,000	50,000
1891	4,000	24,000	1905	4,000	40,000
1892	3,500	21,000	1906	10,000	160,000
1893	3,000	21,000	1907	7,000	60,000
1894	1,800	11,700	1908	6,000	60,000
1895	1,350	9,450	1909	6,961	45,660
1896	500	2,500	1910	1,000	8,000
1897	400	2,800	1911		
1898	400	2,800	1915	1,000	5,000
1899	810	5,900	1916		
1900	3,500	26,250	1920	8	80
1901	5,100	38,250			
1902	4,000	30,000	Totals	88,829	$676,479

MISCELLANEOUS STONE.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38.

'Miscellaneous stone' is the name used throughout this report as the title for that branch of the mineral industry covering crushed rock of all kinds, paving blocks, sand and gravel, and pebbles for grinding mills. The foregoing are very closely related from the standpoint of the producer. Thus it has been found to be most satisfactory to group these items as has been done in recent reports of this Bureau. In so far as it has been possible to do so, crushed rock production has been subdivided into the various uses to which the product was put. It will be noted, however, a very large percentage of the output has been tabulated under the heading 'Unclassified.' This is necessary because of the fact that many of the producers have no way of telling to what specific use their rock was put after they have quarried and sold the same.

In addition to amounts produced by commercial firms, both corporations and individuals, there is hardly a county in the state but uses more or less gravel and broken rock on its roads. Of much of this, particularly in the country districts, there is no definite record kept. Estimates have been made for some of this output, based on the mileage of roads repaired.

For the year 1920 miscellaneous stone shows an increase of nearly 50 per cent in tonnage, and of 85 per cent in total value over the preceding year, being $6,803,557 as compared with $3,698,944 for 1919. This improvement is shared by all classes of building materials, such as cement, bricks and other clay products, as well as stone. The outlook for the current year, 1921, is encouraging, as highway and other construction is increasing.

In 1920, as has been the case for a number of years past, Los Angeles County led all others by a wide margin, with an output valued at $1,704,951; followed by Alameda, second, with $620,758; Fresno, third, $535,587; Contra Costa, fourth, $432,654; San Diego, fifth, $334,847, and Riverside, sixth, $296,499.

Paving Blocks.

The paving block industry has decreased materially of recent years, almost to the vanishing point, because of the increased construction of smoother pavements demanded by motor-vehicle traffic. The blocks made in Solano County were of basalt; those from Sonoma are of basalt, andesite, and some trachyte, while those from Placer, Riverside, San Bernardino, and San Diego are of granite.

Production in 1920 amounted to only 63 M., valued at $3,155, from Riverside and Sonoma counties.

The amount and value of paving block production annually since 1887 has been as follows:

Year	Amount M.	Value	Year	Amount M.	Value
1887	*10,000	$350,000	1905	3,408	$134,347
1888	10,500	367,500	1906	4,203	173,432
1889	7,303	297,236	1907	4,604	199,347
1890	7,000	245,000	1908	7,660	334,780
1891	5,000	150,000	1909	4,503	199,803
1892	*3,000	96,000	1910	4,434	198,916
1893	2,770	96,950	1911	4,141	210,819
1894	2,517	66,981	1912	11,018	578,355
1895	2,332	73,338	1913	6,364	363,505
1896	4,161	77,584	1914	6,053	270,598
1897	1,711	35,235	1915	3,285	171,092
1898	3,144	21,725	1916	1,322	54,362
1899	305	7,861	1917	938	38,567
1900	1,192	23,775	1918	372	17,000
1901	1,920	41,075	1919	27	1,350
1902	3,502	112,437	1920	63	3,155
1903	4,854	134,642			
1904	3,977	161,752	Totals	135,573	$5,308,519

*Figures for 1887–1892 (inc.) are for Sonoma County only, as none are available for other counties during that period; though Solano County quarries were then also quite active.

Grinding Mill Pebbles.

Production of pebbles for tube and grinding mills began commercially in California in 1915. Owing to the decreased imports and higher prices of Belgium and other European flint pebbles, there was a serious inquiry for domestic sources of supply. One of the shipments made in that year was of pebbles selected from gold-dredger tailings in Sacramento County, for use in a gold mill in Amador County employing Hardinge mills.

The important development in this item, however, took place in San Diego County. At several points along the ocean shore from Encinitas south to near San Diego, there are beaches of washed pebbles varying from 1 inch to 6 inches in diameter, which come from conglomerate beds made up of well-rounded water-worn pebbles of various granitic and porphyritic rocks with some felsite and flint. The wave action has broken down portions of the cliffs for considerable distances and formed beaches of the pebbles which are well washed and cleaned of the softer materials. The rocks sorted out for shipment are mainly basalt and diabase, with an occasional felsite and flint pebble. There is a tough black basalt which is stated to give satisfactory results. In Fresno County pebbles have been selected from the gravel beds of the San Joaquin River near Friant. Shipments have been made to metallurgical plants in California, Nevada, Montana and Utah.

There was some resumption of imports in 1919, amounting to 17,677 tons, valued at $250,096, increasing to 23,782 tons and $338,630 in 1920, but the California pebbles still continue to supply a part of the local demand. The output for 1920 was 2,104 tons, valued at $17,988, all from San Diego County. The prices varied from $8 to $10 per ton, f.o.b. shipping point, according to quality, size and shape, the average being $8.55 per ton.

The amount and value of grinding mill pebbles, annually, follows:

Year	Tons	Value
1915	340	$2,810
1916	20,232	107,567
1917	21,450	90,538
1918	8,628	61,268
1919	2,607	19,272
1920	2,104	17,988
Totals	55,361	$299,443

Sand and Gravel Production, by Counties, 1920.

County	Tons	Value	County	Tons	Value
Alameda	[a b]326,087	$265,264	San Bernardino	1,636	$1,418
Contra Costa	30,244	11,703	San Diego	[b]128,416	128,484
Fresno	586,623	283,911	San Francisco	2,000	1,000
Glenn	430,770	128,957	San Joaquin	151,390	63,077
Humboldt	156,342	133,290	San Mateo	11,587	7,640
Imperial	149,980	59,312	Santa Barbara	12,580	12,436
Inyo	575	1,040	Santa Clara	145,150	104,297
Kern	10,138	8,680	Santa Cruz	17,000	8,700
Lake	26,400	13,200	Shasta	20,533	10,266
Lassen	13,000	4,130	Siskiyou	51,328	26,322
Los Angeles	[c]1,587,949	921,432	Sonoma	103,452	44,441
Marin	43,494	18,709	Stanislaus	139,649	141,294
Mariposa	500	200	Trinity	3,000	2,750
Mendocino	6,000	7,500	Tuolumne	4,700	9,340
Merced	39,600	24,800	Ventura	51,581	26,265
Modoc	766	450	Yolo	13,988	9,472
Mono	1,000	1,000	Yuba	151,856	74,943
Monterey	[d]122,966	75,056	Alpine, Butte, Calaveras, Colusa, Placer[b], San Luis Obispo, Solano, Tehama*	248,926	138,808
Napa	99,129	51,375			
Nevada	3,800	2,620			
Orange	40,260	26,988			
Plumas	[a]27,908	61,709			
Riverside	24,463	14,400			
San Benito	28,000	10,250	Totals	5,274,799	$3,014,853
Sacramento	[b]260,039	140,990			

*Combined to conceal output of a single operator in each.
[a]Includes washed gravel.
[b]Includes foundry, moulding, and core sand.
[c]Includes engine sand.
[d]Includes moulding, building, filter, and roofing sand.

A comparison of the table of annual productions of these materials with the similar table for cement (see *ante*), reveals the fact that the important growth of the crushed rock and gravel business was coincident with the rapid development of the cement industry from the year 1902.

Crushed Rock Production, by Counties, for 1920.

County	Macadam and ballast		Rubble and riprap		Concrete		Unclassified		Totals	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
Alameda	205,057	$206,399	687	$1,684	121,541	$188,010	[a]20,191	$19,461	347,476	$415,494
Amador	800	680							800	680
Contra Costa	26,100	29,300	10,040	5,782			342,204	306,132	378,344	341,214
Del Norte	12,000	9,000							12,000	9,000
El Dorado	7,067	5,500							7,067	5,500
Fresno					34,785	29,785	307,077	220,541	341,862	250,326
Lassen	3,592	2,058	400	150	1 733	975			5,725	3,183
Los Angeles					263,615	234,811	460,603	381,000	724,218	615,811
Marin			14,354	20,528					14,354	20,528
Modoc					267	250			267	250
Napa	8,100	6,875			11,670	13,800	2,667	2,500	22,437	23,175
Nevada	6,460	3,908							6,460	3,908
Orange					64,000	54,000			64,000	54,000
Placer	300	200	950	488					1,250	688
Plumas					400	400			400	400
Riverside			67,511	45,541			[c]220,316	192,608	287,827	238,149
Sacramento	430,774	35,578	7,264	3,995					438,038	39,573
San Bernardino	84,050	30,675							84,050	30,675
San Diego					41,583	67,720			41,583	67,720
San Francisco							46,944	72,303	46,944	72,303
San Matea	13,471	17,756					6,119	7,446	19,590	25,202
Santa Barbara	19,467	15,000							19,467	15,000
Santa Clara	17,380	12,285							17,380	12,285
Santa Cruz	5,360	7,304							5,360	7,304
Shasta	24,667	22,450							24,667	22,450
Sonoma	20,443	17,694							20,443	17,694
Tuolumne	4,756	5,356							4,756	5,356

Alpine, Butte, Fresno, Inyo, Los Angeles, Mariposa, Riverside, San Benito, San Diego, San Francisco, San Luis Obispo, Siskiyou, Solano, Stanislaus, Tulare*	534,273	433,963								
Imperial, Los Angeles, San Bernardino, San Mateo, Sonoma, Trinity, Tulare*			421,429	328,898						
Alpine, Contra Costa, Glenn, Imperial, Kern, Marin, Monterey, Riverside, San Francisco, San Mateo, Santa Clara, Santa Cruz, Stanislaus, Tulare, Tuolumne*					283,227	401,071				
Calaveras[b], San Bernardino, San Francisco, Santa Clara, Solano, Sonoma, Stanislaus, Tulare[d]*							341,629	305,761	1,580,558	1,469,693
Totals	1,424,117	$861,981	522,635	$407,066	822,821	$990,822	1,747,750	$1,507,692	4,517,323	$3,767,561

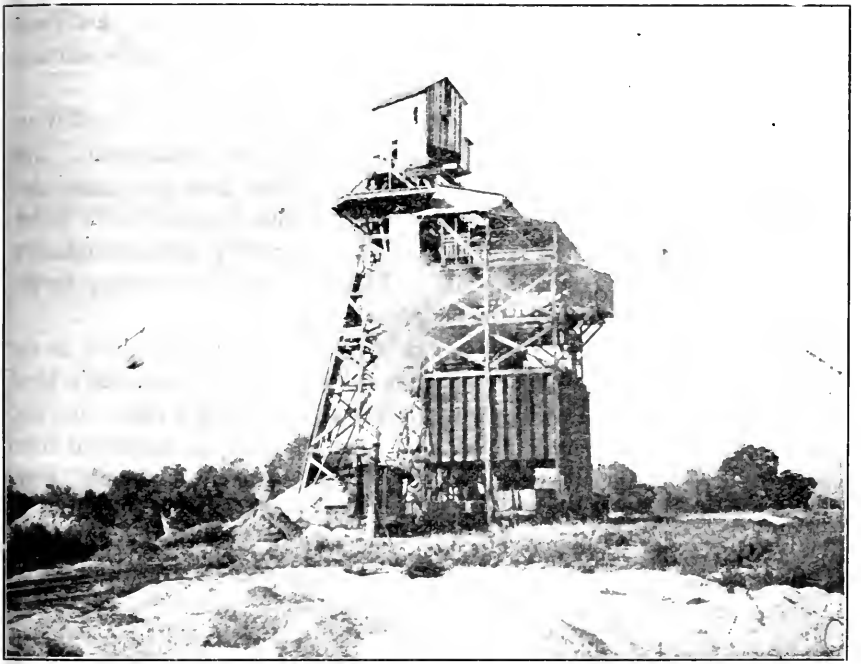
*Combined to conceal output of a single operator in each.
[a]Includes red shale utilized for roofing and linoleum.
[b]Includes greenstone for roofing.
[c]Includes green jasper utilized for roofing.
[d]Includes rock dust, mixed with asphalt in street paving.

Columnar basalt at Dunsmuir, Siskiyou County. Basalt is an excellent material as crushed rock for macadam and concrete.

The amount and value, annually, of crushed rock (including macadam, ballast, rubble, riprap, and that for concrete), and sand and gravel, since 1893, follow:

Crushed Rock, Sand and Gravel, by Years.

Year	Tons	Value	Year	Tons	Value
1893	371,100	$456,075	1908	3,998,945	$3,241,774
1894	661,900	664,838	1909	5,531,561	2,708,326
1895	1,254,688	1,095,939	1910	5,827,828	2,777,690
1896	960,619	839,884	1911	6,487,223	3,610,357
1897	821,123	600,112	1912	8,044,937	4,532,598
1898	1,177,365	814,477	1913	9,817,616	4,823,056
1899	964,898	786,892	1914	9,288,397	3,960,973
1900	789,287	561,642	1915	10,879,497	4,609,278
1901	530,396	641,037	1916	9,951,089	4,009,590
1902	2,056,015	1,249,529	1917	8,069,271	3,505,662
1903	2,215,625	1,673,591	1918	6,641,144	3,325,889
1904	2,296,898	1,641,877	1919	6,919,188	3,678,322
1905	2,624,257	1,716,770	1920	9,792,122	6,782,414
1906	1,555,372	1,418,406			
1907	2,288,888	1,915,015	Totals	121,817,249	$67,642,013



Sand and gravel plant of Fresno Rock Products Company, at Woodrock, on the Kings River, Fresno County. Capacity 700 tons per day.

CHAPTER FIVE.

INDUSTRIAL MATERIALS.

Bibliography: Reports XIV, XV. Bulletin 38. Min. & Sci. Press, Vol. 114, March 10, 1917.

The following mineral substances have been arbitrarily arranged under the general heading of Industrial Materials, as distinguished from those which have a clearly defined classification, such as metals, salines, structural materials, etc.

These materials, many of which are mineral earths, are, with four or five exceptions, as yet produced on a comparatively small scale. The possibilities of development along several of these lines are large and with increasing transportation and other facilities, together with steadily growing demands, the future for this branch of the mineral industry in California is certainly promising. There is scarcely a county in the state but might contribute to the output.

Up to within the last few years, at least, production has been in the majority of instances dependent upon more or less of a strictly local market, and the annual tables show the results of such a condition, not only in the widely varying amounts of a certain material produced from year to year, but in widely varying prices of the same material. Furthermore, the quality of this general class of material will be found to fluctuate, even in the same deposit. The war in Europe affected some of these items, but not to the striking degree that it did the metal markets.

The more important of these minerals thus far exploited, so far as shown by annual value of the output, are limestone, mineral water, pyrite, pottery clays, and diatomaceous earth.

The following summary shows the value of the industrial materials produced in California during the years 1919–1920, with increase or decrease in each instance:

Substance	1919		1920		Increase + Decrease — Value
	Amount	Value	Amount	Value	
Asbestos	*	*	*	*	* —
Barytes	1,501 tons	$18,065	3,029 tons	$20,795	$2,730+
Clay (pottery)	135,708 tons	245,019	203,997 tons	440,689	195,670+
Dolomite	24,502 tons	67,953	42,388 tons	132,791	64,838+
Feldspar	1,272 tons	12,965	4,518 tons	26,189	13,224+
Fuller's earth	385 tons	3,810	600 tons	6,000	2,190+
Gems	----------	5,425	----------	36,056	30,631+
Graphite	*	*	*	*	* —
Gypsum	19,813 tons	50,579	20,507 tons	92,535	41,956+
Infusorial and diatomaceous earths	40,200 tons	217,800	60,764 tons	1,056 260	838,460+
Limestone	88,291 tons	248,145	90,120 tons	298,197	50,052+
Lithia	800 tons	14,400	10,046 tons	153,502	139,102+
Mineral paint	1,780 tons	17,055	779 tons	8,477	8,578—
Mineral water	2,233,842 gals.	340,117	2,391,791 gals.	421,643	81,526+
Pumice and volcanic ash	2,388 tons	43,657	1,537 tons	25,890	17,767—
Pyrite	147,024 tons	540,300	146,001 tons	530,581	9,719—
Silica (sand and quartz)	18,659 tons	101,600	25,324 tons	96,793	4,807—
Soapstone and talc	8,764 tons	115,091	11,327 tons	221,362	106,271+
Total value	----------	$2,041,981	----------	$3,567,760	----------
Net increase	----------	----------	----------	----------	$1,525,779+

*Included under Unapportioned.

ASBESTOS.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38. Canadian Dept. of M., Mines Branch Bulletin 69. Min. and Sci. Press, April 10, 1920, pp. 531–533.

Though asbestos of various grades is known in several localities in California, the production thus far is still small. For the year 1920 the figures are concealed under the 'Unapportioned' item. There was, however, a smaller yield than in 1919. From Nevada County some small shipments of spinning fiber were sent East; but the main part of the output was utilized locally in magnesite-cement stucco, steam-pipe covering, and flooring. Some amphibole was shipped from Shasta County.

The Nevada County material yields a good proportion of medium-length chrysotile with some high-grade spinning fiber. The Sierra Asbestos Company has opened up a promising deposit there, and has been milling its rock in an old 20-stamp gold mill converted to their purposes, to which fiberizing machinery has been added. For the current year an increased output is expected, as improvements have been made in the equipment. The Long-Ryan Asbestos Company reports (June, 1921) shipping chrysotile from a deposit which they are opening up on Clear Creek, near Hernandez, San Benito County. Chrysotile of good-quality fiber, though short, has also been found in Calaveras, Fresno, Lake, Napa, and Trinity counties.

The bulk of the world's supply of this mineral comes from Canada; and Canadian asbestos, until recently, has led in length of fiber as well as in quality. It is now equaled, if not excelled, by fibre produced in Arizona.

Classification and Characteristics.

The word asbestos (derived from the Greek, meaning incombustible) as used here includes several minerals, from a strictly mineralogical standpoint. There are two main divisions, however: amphibole and chrysotile. The fibrous varieties of several of the amphiboles (silicates chiefly of lime, magnesia and iron), notably tremolite and actinolite, are called asbestos. Their fibres usually lie parallel to the fissures containing them. Amphibole asbestos possesses high refractory properties, but lacks strength of fibre, and is applicable principally for covering steam pipes and boilers. Chrysotile, a hydrous silicate of magnesia, is a fibrous form of serpentine, and often of silky fineness. Its fibres are formed at right angles to the direction of the fissures containing them. Chrysotile fibres, though short, have considerable strength and elasticity, and may be spun into threads and woven into cloth. To bring the highest market price asbestos must needs have a combination of properties, *i. e.*, length and fineness of fibre, tensile strength and flexibility—all combined with infusibility. Of these qualities the most important are toughness and infusibility, and determination of the same can only be made by practical tests or in the laboratory.

Asbestos, roughly speaking, was worth from $20 to $200 per ton, before the war. Under the stimulus of war conditions, the demand has caused a material increase in prices. The poorer grades which are unsuitable for weaving and which, of course, command the lower prices, are used in the manufacture of steam packing, furnace linings, asbestos brick, wall plasters, paints, tiling, asbestos board, shingles, insulating material, magnesite-stucco, etc. The better grades are utilized in the manufacture of tapestries of various kinds, fireproof theater curtains, cloth, rope, etc.

A very important development of the asbestos industry is the rapidly increasing demand for the lower grade material, on account of the numerous diversified uses to which asbestos products are being put, in almost every branch of manufacture. This fact means that many deposits of asbestos will become commercially important even though the grade of the material is far from the best.

It has been found that not only does an asbestos wall-plaster render the wall so covered impervious to heat, but that in rooms which have given forth an undesirable echo this evil has been absolutely removed. Asbestos pulp mixed with magnesite-cement has been experimented

with; and roofing, flooring, and other building material of the most satisfactory sort has been manufactured therefrom.

Asbestos Grading.

Chrysotile asbestos is graded by the trade into the following classes: Crude No. 1; Crude No. 2; Mill Stock, Nos. 1, 2, and 3. The method of grading is described as follows:[1]

"We use the standard method of testing, namely, the shaking screen machine.
"We take one pound and shake it for two minutes at 300 revolutions per minute.
"The machine consists of four wooden trays about 5 inches deep, 16 inches by 26 inches. The bottoms of three of these trays are made of wire cloth screen of different meshes. The bottom tray is lined with zinc. The trays are numbered from 1 down, No. 1 being the coarsest screen, No. 2 medium, No. 3 fine. No. 4 is the box for the receptacle of sand and short fibres.
No. 1 screen is 2 mesh 11 gauge.
No. 2 screen is 4 mesh 17 gauge.
No. 3 screen is 10 mesh 18 gauge.
"After the shaking has taken place, the residue in each box is weighed and the total weight of sixteen ounces is arrived at. The more found on the first box the better the fibre, and so on."

'Crude' is the designation applied to the hand-cobbed, high-grade lumps of long-fibre material that does not require preliminary milling. Even in Canada this class comprised in 1918 and 1919 less than 0.2% of the total rock mined, and averaged 2.5%–3% of the total merchantable asbestos.[2] For 1920, shipments of all grades from Quebec totaled 174,521 tons valued at $11,758,234. Prices are being maintained for the current year, during this period of economic readjustment, by curtailing the output.

Value and Production.

Total amount and value of asbestos production in California since 1887, as given in the records of this Bureau, are as follows:

Year	Tons	Value	Year	Tons	Value
1887	30	$1,800	1905	112	$2,625
1888	30	1,800	1906	70	3,500
1889	30	1,800	1907	70	3,500
1890	71	4,260	1908	70	6,100
1891	66	3,960	1909	65	6,500
1892	30	1,830	1910	200	20,000
1893	50	2,500	1911	125	500
1894	50	2,250	1912	90	2,700
1895	25	1,000	1913	47	1,175
1896			1914	51	1,530
1897			1915	143	2,860
1898	10	200	1916	145	2,380
1899	30	750	1917	136	10,225
1900	50	1,250	1918	229	9,903
1901	110	4,400	1919	*	*
1902			1920	*	*
1903					
1904	10	162	Totals	2,145	$161,460

*Under Unapportioned.

[1] "Asbestos crude and fibre," a booklet issued by the Asbestos and Mineral Corporation, New York, 1921, p. 27.

[2] U. S. Commerce Reports, No. 84, April 12, 1921; tables of production on page 250.

BARYTES.

Bibliography: State Mineralogist Reports XII, XIV, XV. Bulletin 38.

The output of crude barytes during 1920 was 3029 tons, valued at $20,795 as compared with the 1919 production of 1501 tons, worth $18,065. The principal use for barytes is in the paint industry; also in certain rubber articles. For the former purpose, the material should show pure white after grinding. Lithopone is a chemically prepared white pigment containing about 70% barium sulphate and 30% zinc sulphide, and is one of the principal constituents of 'flat' wall paints now so extensively used in office buildings and hospitals, replacing both paper and calcimine wall finishes. Minor uses are in tanning of leather, manufacture of paper and rope, and sugar refining. Most of the 1920 output of California was utilized in the manufacture of lithopone and blanc fixe.

Known occurrences of this mineral in California are located in Inyo, Los Angeles, Mariposa, Monterey, Nevada, San Bernardino, Shasta, and Santa Barbara counties. The deposit at El Portal, in Mariposa County, has given the largest commercial production to date, in part, witherite (barium carbonate, $BaCO_3$). The 1915 output was the first commercial production of the carbonate in the United States, of which we have record. In 1916, output began from a deposit opened up on Fremont's Peak, Monterey County, near the line of San Benito County, and in 1919–1920 shipments were also made from Nevada County. Shasta County is reported in the list for 1921.

The first recorded production of barytes in California, according to the statistical reports of the State Mining Bureau, was in 1910. The annual figures are as follows:

Year	Tons	Value	Year	Tons	Value
1910	860	$5,640	1917	4,420	$25,633
1911	309	2,207	1918	100	1,500
1912	564	2,812	1919	1,501	18,065
1913	1,600	3,680	1920	3,029	20,795
1914	2,000	3,060			
1915	410	620	Totals	16,399	$89,468
1916	1,606	5,516			

CLAY—POTTERY.

Bibliography: State Mineralogist Reports I, IV, IX, XII, XIII, XIV, XV. Bulletin 38. Preliminary Report, No. 7.

At one time or another in the history of the state, pottery clay has been quarried in thirty-three of its counties. In this report pottery clay refers to all clays used in the manufacture of red and brown earthenware, sanitary ware, flowerpots, ornamental tiling, architectural terra

cotta, sewer pipe, drain and roof tile, etc., and the figures for amount and value are relative to the crude material at the pit, without reference to whether the clay was sold in the crude form, or whether it was immediately used in the manufacture of any of the above finished products by the producer. It does not include clay used in making brick and building blocks.

During 1920 a total of 43 producers in 12 counties reported an output of 203,997 tons of clay, having a spot value of $440,689 for the crude material, at the pits, as compared with the 1919 production of 135,708 tons worth $245,019.

This considerable increase in production of pottery clays and their products of all kinds, coupled with the increase shown by brick and building blocks (see Chapter IV, *ante*), is an indication of the resumption of building operations throughout the state, which had been curtailed during the war period.

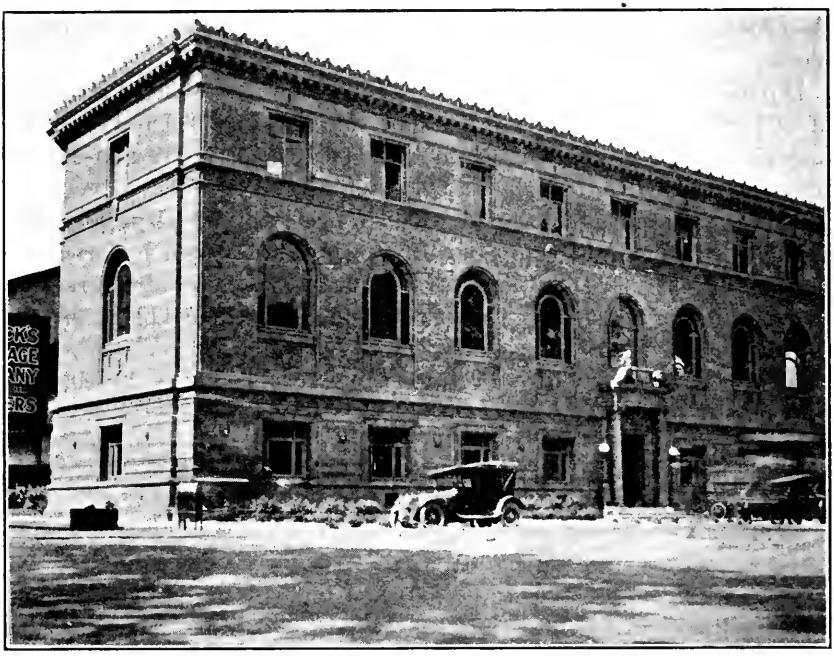
A tabulation of the direct returns from the producers, by counties, for the year 1920, is shown herewith:

County	Tons	Value	Used in the manufacture of—
Alameda	3,001	$3,762	Terra cotta and sewer pipe.
Amador	[c]25,719	61,808	Architectural terra cotta, stoneware, porcelain, refractories, et al.
Contra Costa	1,743	3,319	Architectural terra cotta, faience tile, and refractories.
Los Angeles	[a b c]18,684	91,763	White ware, refractories, roofing and faience tile, toilet articles, et al.
Placer	65,560	76,500	Architectural terra cotta, sewer pipe, sanitary ware, drain and roof tile, chimney pipe, and flue lining.
Riverside	[a]76,317	126,313	Tile, terra cotta, chinaware, stoneware, chemical ware, sewer pipe, refractories and drain tile.
San Bernardino	[d]95	890	Chemical stoneware, terra cotta, faience tile, et al.
San Diego	[e]5,852	57,522	Stoneware, pottery, and petroleum refining.
Santa Clara	1,900	4,600	Sewer pipe, red earthenware and stoneware.
Humboldt, Lassen and Orange*	5,126	14,212	Art pottery and drain tile.
Totals	203,997	$440,689	

*Combined to conceal output of a single operator in each.
[a]Includes crushed brick and grog.
[b]Includes crushed clay for roofing.
[c]Includes kaolin.
[d]Includes colloidal clay used in soap making.
[e]Includes montmorillonite ore 'rock soap' used in petroleum refining, soap and kalsomine manufacture; also includes 'Cornish stone,' used for pottery.

Because of the fact that a given product often requires a mixture of several different clays, and that these are not all found in the same pit, it is necessary for most clay-working plants to buy some part of their raw materials from other localities. For these reasons, in compiling the clay industry figures, much care is required to avoid duplications. So far as we have been able to segregate the figures, from the data sent in

by the operatives, we have credited the clay output to the counties from which the raw material originated; and have deducted tonnages used in brick manufacture, as bricks are classified separately, herein.

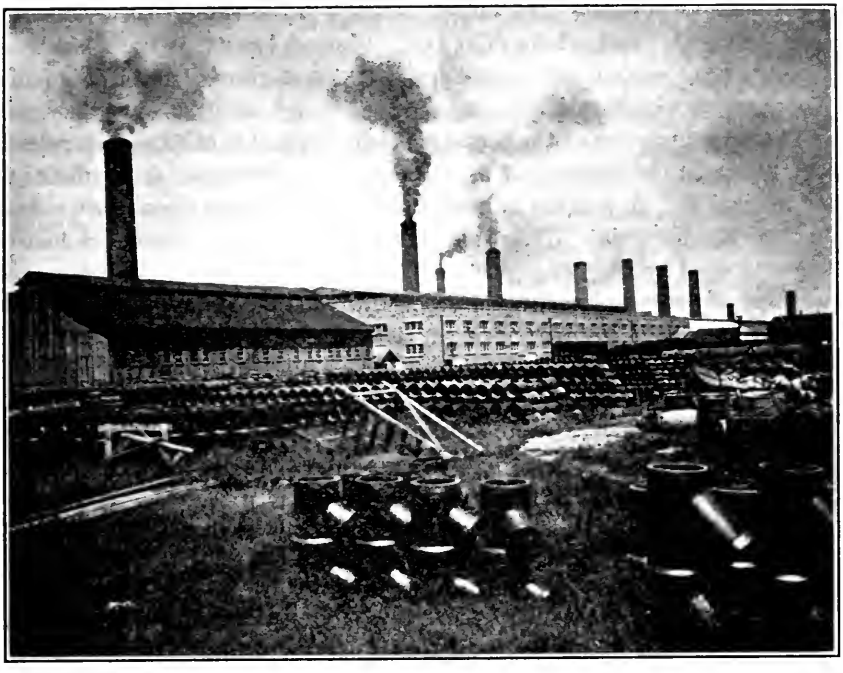


Sacramento City Library, finished with architectural terra cotta and fancy bricks from plant of Gladding-McBean Company, Lincoln, Placer County.

The values of the various pottery clay products made in California during 1920 totaled $3,923,518 compared with $2,076,280 in 1919, their distribution being shown in the following tabulation:

Values of Pottery Clay Products, 1920.

Product	Number of producers	Value
Architectural terra cotta	5	$1,092,198
Chimney pipe, terra cotta and flue linings	4	102,468
Drain tile	7	71,525
Roofing tile	4	340,741
Sewer pipe	6	954,906
Stoneware, chemical and sanitary ware	8	1,103,686
Red earthenware	3	104,741
Floor, faience, glazed and hand-made tile	9	57,946
Miscellaneous, art pottery, terra cotta, garden furniture, mortar colors, vitrified conduit, bisque ware and doll heads	5	95,307
Total value		$3,923,518



Pottery Plant of Gladding-McBean Company, at Lincoln, Placer County.

Amount and value of crude pottery clay output in California since 1887 are given in the following table:

Year	Tons	Value	Year	Tons	Value
1887	75,000	$37,500	1905	133,805	$130,146
1888	75,000	37,500	1906	167,267	162,283
1889	75,000	37,500	1907	160,385	254,454
1890	100,000	50,000	1908	208,042	325,147
1891	100,000	50,000	1909	299,424	465,647
1892	100,000	50,000	1910	249,028	324,099
1893	24,856	67,284	1911	224,576	252,759
1894	28,475	35,073	1912	199,605	215,683
1895	37,660	39,685	1913	231,179	261,273
1896	41,907	62,900	1914	179,948	167,552
1897	24,592	36,290	1915	157,866	133,724
1898	28,947	33,747	1916	134,636	146,538
1899	40,600	42,760	1917	166,298	154,602
1900	59,636	60,956	1918	112,423	166,788
1901	55,679	39,144	1919	135,708	245,019
1902	67,933	74,163	1920	203,997	440,689
1903	90,972	99,907			
1904	84,149	81,952	Totals	4,074,593	$4,776,704

DOLOMITE.

Bibliography: Report XV. Bulletin 67.

Previous to the 1915 report dolomite was included under limestone. Limestones are frequently more or less magnesian-bearing, and a chemical analysis is often necessary to definitely decide as to whether they

are calcite or dolomite; the latter standing intermediate between magnesite ($MgCO_3$) and calcite ($CaCO_3$). Since dolomite, as such, has been found to have certain distinctive applications, we have deemed it worthy of a separate classification.

The major portion of the tonnage being shipped is utilized as a refractory lining in the bottoms of open-hearth steel furnaces, as a substitute for magnesite. A portion is used for its carbonic acid gas (CO_2), and part for its magnesia. We are also informed that some calcined dolomite has been used by the paper mills. As dolomite contains the proper proportions of lime and magnesia, it can replace an artificial mixture of calcined limestone and magnesite in the sulphite process of manufacture of paper from wood pulp. Dolomite is also sometimes used as a flux in metal smelting.

The production of dolomite for the year 1920 amounted to 42,388 tons, valued at $132,791, and came from a total of 9 quarries in 5 counties, distributed as follows:

County	Tons	Value
Monterey	5,755	$26,238
San Benito	18,000	57,750
Inyo, San Bernardino, Tuolumne*	18,633	48,803
Totals	42,388	$132,791

*Combined to conceal output of a single operator in each.

Amount and value of the output of dolomite, annually, have been as follows:

Year	Tons	Value
1915	4,192	$14,504
1916	13,313	46,566
1917	27,911	66,416
1918	24,560	79,441
1919	24,502	67,953
1920	42,388	132,791
Totals	136,866	$407,671

FELDSPAR.

Bibliography: Report XV. Bulletin 67. U. S. Bur. of M., Bull. 92.

Feldspar was produced by seven operators in four counties during 1920, to the amount of 4518 tons, valued at $26,189.

Feldspar production only dates back to 1910 in California. The mineral is a constituent of many rocks, but can only be commercially produced from pegmatites where the crystals are large and quite free from impurities. The open-cut method of mining this material is commonly used. Manufacturers of enamel wares and pottery buy most of the better grades of feldspar produced. Small quantities are used in the manufacture of glass and scouring soaps, and the more impure

material is used as chicken grit, in making various brands of roofing, and in other ways. Various experiments have been made with the potash feldspars in the attempt to extract their potash content for use in fertilizers. The most successful of these has been accomplished through the medium of cement manufacture, and recovery of the potash as a by-product.

[1]"The requirements of the pottery trade demand that in general the percentage of free quartz associated with the feldspar used for this purpose shall not exceed 20 per cent in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent of free quartz. In order to be profitably worked in most feldspar mines between one-fourth and one-half of the total material that must be excavated should contain less than 20 per cent of free quartz. Freshness of the feldspar, though desirable, is not essential.

"A factor of the utmost importance in the mining of pottery spar is the quantity of iron-bearing minerals (black mica, hornblende, garnet, black tourmaline, etc.) present and the manner in which these minerals are associated with the feldspar. The requirements of the pottery trade demand that the spar be nearly free from these minerals. In order that a deposit may be worked profitably these minerals, if present in any appreciable quantity, must be so segregated in certain portions of the deposit that they can be separated from the spar without much more hand sorting and cobbing than is necessary anyway in the separation of the highly feldspathic material from that which is highly quartzose or rich in muscovite. The presence here and there of minute flakes of white mica (muscovite) is characteristic even of the highest grades of commercial feldspar, and this mineral is not injurious except in so far as it is exceedingly difficult to pulverize the thin, flexible mica plates to a fineness equal to that required in the feldspar, and it is therefore necessary in mining to separate carefully as much of the muscovite as possible from the spar.

"Recently potash feldspars have been sought as a source of potash salts and also by reason of their potash content for incorporation in so-called complete fertilizers. For such purposes the prices paid are generally less than for pottery feldspar of first and second grade, and if such use of feldspar is found practicable the quantities required will be far in excess of those heretofore annually required by the pottery industries. To supply such a demand pegmatite deposits must be of large size and very favorably located with respect to transportation facilities and market.

"The requirements for extraction of potash and for use in fertilizer are a high potash content and convenience of location. The presence of quartz and of iron-bearing and other minerals in small quantities is of no significance. Both white and black mica are potash-bearing minerals and therefore not wholly undesirable.

"Almost any coarse, undecomposed granite pegmatite is adapted to the manufacture of roofing materials and poultry grit, but these products command such low prices that they can be marketed only under very favorable conditions."

The most important recent developments in feldspar deposits in California have taken place in San Diego and Riverside counties, where large deposits of massive, high-grade spar are being opened up. These deposits are unusually free from black mica and other deleterious iron-bearing minerals which are objectionable in pottery work. The important districts are near Lakeside and Campo in San Diego County, and near Lakeview, Murrietta, and Elsinore, in Riverside County. In Kern County, for the current year (1921), the cement plant at Monolith is reported utilizing feldspar from Rosamond as a source for by-product potash.

Total amount and value of feldspar production in California since the inception of the industry are given in the following table, by years:

Year	Tons	Value	Year	Tons	Value
1910	760	$5,720	1917	11,792	$46,411
1911	740	4,560	1918	4,132	22,061
1912	1,382	6,180	1919	1,272	12,965
1913	2,129	7,850	1920	4,518	26,189
1914	3,530	16,565			
1915	1,800	9,000	Totals	34,685	$171,846
1916	2,630	14,350			

[1]Katz, F. J., Feldspar in 1916: U. S. Geol. Surv., Min. Res. of U. S., 1916, Part II, p. 175, 1917.

FLUORSPAR.

Bibliography: Bulletin 67.

Fluorspar is used as a flux in steel and iron smelting, and in the production of aluminum. It is also utilized in the manufacture of hydrofluoric acid, glass, porcelain, enamels and sanitary ware.

[1]"The market for the bulk of the fluorspar sold in the United States depends on the steel industry and the demand fluctuates with the rise and fall in the production of steel. Gravel spar is consumed as a flux in basic open-hearth steel furnaces and to a smaller extent in other metallurgical operations . In both 1914 and 1915 the sales of gravel spar constituted between 83 and 84 per cent of the total marketed output of domestic fluorspar, and in 1916 it was nearly 86 per cent. Fluorspar is used also as a flux in iron blast furnaces, iron foundries, and in gold, silver, copper, and lead smelters; in the manufacture of fluorides of iron and manganese for steel fluxing and of sodium fluoride for wood preservation[2]; in the manufacture of glass, enameled, and sanitary ware, and of hydrofluoric acid; in the electrolytic refining of antimony and lead; and in the production of aluminum. Other miscellaneous uses of fluorspar that have been reported are as a bonding for constituents of emery wheels, for carbon electrodes, in the extraction of potash from feldspar, and in the recovery of potash in Portland cement manufacture. The last use depends on the suitability of calcium fluoride as a reagent for increasing the volatilization of potassium salts from the clinker and the regeneration of the reagent from the dust collected.[3]"

In California, deposits have been reported in Los Angeles, Mono, Riverside, and San Bernardino counties, but up to 1917 no commercial production had resulted. As the 1917-1918 output came from a single operator in Riverside County, the amount and value were concealed under the Unapportioned item. There was none shipped in 1919 or 1920. At the King mine, near Afton in San Bernardino County, a large deposit is being opened up, which may become an important source, commercially, of this mineral. Analyses reported show an average of over 90% calcium fluoride (CaF_2).

The general average price per ton f.o.b. mines or shipping points (eastern states), for all grades of fluorspar in 1920, was $25.26, according to the U. S. Geological Survey.

FULLER'S EARTH.

Bibliography: Bulletin 38. U. S. Bureau of Mines, Bulletin 71.

Fuller's earth production in California during the year 1920 amounted to 600 tons, valued at $6000, as compared with 385 tons, valued at $3810 in 1919.

Fuller's earth includes many kinds of unctuous clays. It is usually soft, friable, earthy, nonplastic, white and gray to dark green in color, and some varieties disintegrate in water. Like all other clays, fuller's earth is a hydrous aluminum silicate, but usually contains a higher percentage of water of composition than most clays. This water is not an essential factor in the bleaching properties of all fuller's earths, as some bleach fully as well after it has been driven off as before, and others lose

[1]Burchard, E. F., Fluorspar and cryolite in 1916: U. S. Geol. Surv., Min. Res. of U. S., 1916, Part II, p. 315, 1917.

[2]Teesdale, C. H., Use of fluorides in wood preservation: Wood Preserving, vol. 3, No. 4; vol. 4, No. 1. (Reprint, 9 pp.)

[3]Treanor, John, Potash from cement at the Riverside Portland Cement Co.; Met. and Chem. Eng., June 15, 1917, pp. 701-703.

much of their bleaching power when this water is removed. All fuller's earths which have been found valuable for bleaching purposes show a distinctly so-called 'acid reaction.' (If a sample is touched to neutral litmus paper the paper will be turned red). Chemical analyses are now well understood to be no criterion in determining the classification of a given clay as 'fuller's earth.' The final determination is a commercial one as to its capacity for absorbing basic colors and removing these colors from solution in animal, vegetable or mineral oils, also from water.

[1]"The Shipping Board's Inquiries also brought out the interesting information that only domestic fuller's earth is used for the refining of mineral oils. There appears, on the other hand, to be a difference of opinion as to the suitability of the domestic earth for use in refining edible oils. Some of the larger users of fuller's earth, anticipating a shortage of imported material, began early in the war to experiment with domestic earths in refining edible oils and fats, with results so satisfactory that they became independent of imported earth. Others stated that they had experimented with every known domestic earth, but had not found one that completely met the requirements to supplant the imported earth. The requirements of a good earth for refining edible oils are (1) that it shall bleach well and that the oil shall not revert to its original color; (2) that it shall filter well and not cake badly; (3) that it shall leave no permanent disagreeable taste or odor; (4) that the retention of oil in the spent earth shall be small; and (5) that there shall be no spontaneous ignition either in the press or in the waste piles. Those who use the imported earth claim that it is standard in all of these requirements, and that the domestic earth is deficient in one or more of them. Such a defect as inability to bleach well appears to be inherent in some domestic earth, and can not be remedied by treatment. Other defects, such as the taste or odor left by the earth, which is the most frequent objection urged against the domestic material, may possibly be overcome by treatment. Another serious fault charged against the American earth is that it retains a greater proportion of oil than the English earth, which means a direct loss in production; also that it clogs the filter presses more, so that they require more frequent cleaning, which causes further decrease in production. It is also charged that domestic earth is more subject to spontaneous combustion."

In California, fuller's earth has been used in clarifying both refined mineral and vegetable oils, although its original use was in fulling wool, as the name indicates. Some of the 1919 product was used for special chemical purposes. Production has mainly come from Calaveras and Solano counties. Deposits have also been found in Riverside, Fresno, Inyo, and Kern counties. Experiments are being conducted by some of the large oil refiners, with clays of the montmorillonite and halloysite group ('rock soap') to determine their suitability, or efficacy as a substitute for fuller's earth in the refining of petroleum products.

It was first produced commercially in this state in 1899, and the total amount and value of the output since that time are as follows:

Year	Tons	Value	Year	Tons	Value
1899	620	$12,400	1911	466	$5,294
1900	500	3,750	1912	876	6,500
1901	1,000	19,500	1913	460	3,700
1902	987	19,246	1914	769	5,928
1903	250	4,750	1915	692	4,002
1904	500	9,500	1916	110	550
1905	1,344	38,000	1917	220	2,180
1906	440	10,500	1918	37	333
1907	100	1,000	1919	385	3,810
1908	50	1,000	1920	600	6,000
1909	459	7,385			
1910	340	3,820	Totals	11,196	$169,148

[1]Middleton, Jefferson, Fuller's Earth in 1918: U. S. Geol. Surv., Min. Res. of U. S. 1918, Part II, p. 136, 1919.

GEMS.

Bibliography: State Mineralogist Reports II, XIV, XV. Bulletins 37, 67.

Accounting for the production of gems in California is somewhat unsatisfactory, owing to the widely scattered places at which stones are gathered and marketed in a very small way. The following table shows the production, by counties, of rough uncut materials during 1920:

County	Value	Kind
Butte	$400	Diamonds.
San Diego	2,100	Tourmaline, beryl, topaz, hyacinth, quartz, garnet.
Calaveras	*33,556	Quartz crystals for optical purposes.
Kern		Yellow moss opal.
Modoc		Iceland spar crystals, for optical purposes.
Riverside		Quartz crystals.
San Bernardino		Myrickite, bloodstone, chalcedony.
Total	$36,056	

*Combined to conceal output of a single operator in each.

The considerable increase in 1920 over the value of $5425 in 1919 is due mainly to shipments of quartz crystals from Calaveras County and Iceland spar from Modoc County, both of which were sold for optical purposes, which demand material of gem quality and freedom from flaws.

Between 1912 and 1920, the gem output of California has been small, owing to the lack of demand.

California tourmalines are decidedly distinctive in coloring and 'fire' as compared to foreign stones of this classification. The colors range from deep ruby to pink, and various shades of green; also a blue tourmaline has been found.

Two of our California gem stones, kunzite and benitoite, are not found elsewhere; and these, each in but a single locality here: the former in Pala Chief Mine in San Diego County, and the latter in the Dallas Mine in San Benito County.

Californite, or 'California jade,' is a gem variety of vesuviante, and is green or white in color.

Some rhodonite has been mined in Siskiyou County, and used for decorative purposes, its value being included in the marble figures.

Diamonds have been found in a number of localities in California; but in every case, they have been obtained in stream gravels while working them for gold. The principal districts have been: Volcano in Amador County; Placerville, Smith's Flat and others in El Dorado County; French Corral, Nevada County; Cherokee Flat and Yankee Hill, Butte County; Gopher Hill and upper Spanish Creek, Plumas County. The most productive district of recent years has been Cherokee in Butte

County. One stone weighing 1.85 carats was found in Morris Ravine, near Cherokee, in 1920.

Chrysoprase has been produced in Tulare County.

The value of the total gem production in California annually since the beginning of commercial production is as follows:

Year	Value	Year	Value
1900	$20,500	1912	$23,050
1901	40,000	1913	13,740
1902	162,100	1914	3,970
1903	110,500	1915	3,565
1904	136,000	1916	4,752
1905	148,500	1917	3,049
1906	497,090	1918	650
1907	232,642	1919	5,425
1908	208,950	1920	36,056
1909	193,700		
1910	237,475	Total	$2,133,538
1911	51,824		

GRAPHITE.

Bibliography: State Mineralogist Reports XIII, XIV, XV. Bulletin 67. U. S. G. S., Min. Res., 1914, Pt. II.

Graphite has been produced from time to time in the state, coming principally from Sonoma and Los Angeles counties. It is difficult for these deposits, which are not high grade, to compete with foreign supplies which go on the market almost directly as they come from the deposit. Low-grade ores are concentrated with considerable difficulty and the electric process of manufacturing artificial graphite from coal has been perfected to such a degree that only deposits of natural graphite of a superior quality can be exploited with any certainty of success.

According to a recent report by U. S. Geological Survey, "at present prices, miners in this country who are working disseminated flake deposits must depend on their No. 1 and 2 flake for their profit. Graphite dust is merely a by-product and is salable only at a low price. Improved methods of graphite milling, adopted * * * promise to increase largely the production of flake of better grade."

On account of its infusibility and resistance to the action of molten metals, graphite is very valuable. It is also largely used in the manufacture of electrical appliances, of 'lead' pencils, as a lubricant, as stove polish, paints, and in many other ways. Amorphous graphite, commonly carrying many impurities, brings a much lower price. For some purposes, such as foundry facings, etc., the low-grade material is satisfactory. The price increases with the grade of the material until the best quality crystalline variety ordinarily ranges as high as $200 per ton. Because of

Open-cut graphite on outcrop 50 feet wide. California Graphite Company deposit, San Francisquito Cañon, Los Angeles County.
Photo by courtesy of the Company.

the increased demand during the war period for brass and crucible steel, the requirement for graphite crucibles grew rapidly, thus boosting the price of flake graphite to above $400 per ton for Ceylon lumps. The coarser flakes are necessary for crucibles, as they help to bind the clay together in addition to their refractory service. Since the close of hostilities in Europe, prices have declined to nearly the pre-war level; and imports have been resumed from Ceylon, Canada and Madagascar, Mexico, Canada, Korea, and others in the order named of a total of 21,095 tons valued at $1,711,312 in 1920. Nearly 50% of this was from Ceylon.

Among the newer uses for graphite is the prevention of formation of scale in boilers. The action is a mechanical one. Being soft and slippery, the graphite prevents the particles of scale from adhering to one another or to the boiler and they are thus easily removed.

Occurrence of graphite has been reported at various times from Calaveras, Fresno, Imperial, Los Angeles, Mendocino, San Bernardino, San Diego, Siskiyou, Sonoma and Tuolumne counties.

During 1920 a slightly decreased production was reported from Los Angeles County. It was concentrated from a disseminated ore, and was used for paint, foundry facing, and lubricants. As there was but a single operator, the figures are concealed under the 'Unapportioned' item. The production, by years, has been as follows:

Year	Pounds	Value
1901	128,000	$4,480
1902	84,000	1,680
1903		
1913	2,500	25
1914		
1915		
1916	29,190	2,335
1917		
1918	*770,000	37,225
1919		
1920		
Totals	1,013,690	$45,745

*Concealed under 'Unapportioned,' on account of a single producer.

GYPSUM.

Bibliography: Reports XIV, XV. Bulletins 38, 67.

Gypsum is widely distributed throughout the state, and is produced to a considerable extent, to supply the fertilizer manufacturers and also those of plaster and cement.

The action of gypsum as a fertilizer was formerly considered to be indirect[1]; that it was not a food for plants, but it is supposed to act on the double silicate of magnesia and potash in the soil, freeing the magnesia and potash, so that they become available as plant food. Its use

[1]U. S. G. S. Press Bulletin No. 374, July, 1918, p. 4.

was believed to be beneficial only if these elements are present in the soil. More recently, investigations are stated to prove that gypsum serves as a source of both sulphur and calcium, which are plant foods.

Some authorities hold that land plaster tends to make nonporous clay soils more pervious to water and to make sandy soils less pervious. Ground gypsum has an affinity for water and will draw moisture from the atmosphere, so it keeps moisture in the soil and is of value to the farmer who is starting grain and grass crops, as it holds moisture where the roots of the small plants most need it. The use of ground gypsum or land plaster in a dry, hot season may draw enough moisture from the atmosphere to save a crop from damage by drought. Land plaster is employed to neutralize the black alkali that forms in many of the soils of arid regions, as in parts of California, Nevada and Utah.

Land plaster may be applied to the soil by drilling, or scattered in the hill, or it may be sowed broadcast, in quantities ranging from 200 to 500 pounds to the acre.

In the calcined form as plaster of Paris, gypsum plays a very important part in surgical work. It is also widely used in building operations, as a hard-wall plaster, as plaster board, etc.

During 1920, producers in Riverside and San Bernardino counties took out a total of 20,507 tons, valued at $92,535, being an increase from the 19,813 tons, valued at $50,579, in 1919.

Total annual production of gypsum in California since such records have been compiled by this Bureau is as follows:

Year	Tons	Value	Year	Tons	Value
1887	2,700	$27,000	1905	12,859	$54,500
1888	2,500	25,000	1906	21,000	69,000
1889	3,000	30,000	1907	8,900	57,700
1890	3,000	30,000	1908	34,600	155,400
1891	2,000	20,000	1909	30,700	138,176
1892	2,000	20,000	1910	45,294	129,152
1893	1,620	14,280	1911	31,457	101,475
1894	2,446	24,584	1912	37,529	117,388
1895	5,158	51,614	1913	47,100	135,050
1896	1,310	12,580	1914	29,734	78,375
1897	2,200	19,250	1915	20,200	48,953
1898	3,100	23,600	1916	33,384	59,533
1899	3,663	14,950	1917	30,825	56,840
1900	2,522	10,088	1918	19,695	37,176
1901	3,875	38,750	1919	19,813	50,579
1902	10,200	53,500	1920	20,507	92,535
1903	6,914	46,441			
1904	8,350	56,592	Totals	510,146	$1,899,461

INFUSORIAL and DIATOMACEOUS EARTHS.

Bibliography: State Mineralogist Reports II, XII, XIII, XIV, XV. Bulletins 38, 67. Am. Inst. Min. Eng., Bull. 104, August, 1915, pp. 1539-1550.

Infusorial and diatomaceous earths—sometimes called tripolite—are very light and extremely porous, chalk-like materials composed of pure silica (chalk, being calcareous) which have been laid down under water and consist of the remains of microscopical infusoria and diatoms. The former are animal remains, and the latter are from plants. The principal commercial use of this material is as an absorbent; and it is also employed in the manufacture of scouring soap and polishing powders, and in making some classes of refractory brick, and as an insulating medium both in heating and refrigeration. It is a first-class nonconductor of heat, where high temperatures are employed, such as around steel and gas plants and power houses. In such cases, it is built in as an insulating layer in furnace walls. In Germany, under the name "kieselguhr," it was used as an absorbent for nitroglycerine in the early manufacture of dynamite.

As a non-conductor of heat it has been used alone or with other materials as a covering for boilers, steam pipes, and safes and in fireproof cements. It is used largely by paint manufacturers as a wood filler. Boiled with shellac it is made into records for talking machines. It has been used for absorbing liquid manures so that they could be utilized as fertilizers, and as a source of silica in making water-glass as well as in the manufacture of cement, tile glazing, artificial stone, ultra-marine and other pigments of aniline and alizarine colors, paper filling, sealing wax, fireworks, hard-rubber objects, matches, and papier maché, and for solidifying bromine. For making insulating brick the material is sawed from blocks, and for all other purposes it is ground and screened.

The most important deposits in California thus far known are located in Monterey, Orange, San Luis Obispo, and Santa Barbara counties. The Santa Barbara material is diatomaceous and is of a superior quality. Infusorial earth is also found in Fresno, Kern, Los Angeles, Plumas, San Benito, San Bernardino, San Joaquin, Shasta, Sonoma, and Tehama counties.

During 1920, five quarries operating in Los Angeles, Monterey and Santa Barbara counties, produced a total of 60,764 tons, valued at $1,056,260, which is a material increase over the 40,200 tons, valued at $217,800 in 1919.

The first recorded production of these materials in California occurred in 1889; total amount and value of output, to date, are as follows:

Year	Tons	Value	Year	Tons	Value
1889	39	$1,335	1906	2,430	$14,400
1890	----------	----------	1907	2,531	28,948
1891	----------	----------	1908	2,950	32,012
1892	----------	----------	1909	500	3,500
1893	50	2,000	1910	1,843	17,617
1894	51	2,040	1911	2,194	19,670
1895	----------	----------	1912	4,129	17,074
1896	----------	----------	1913	8,645	35,968
1897	5	200	1914	12,840	80,350
1898	----------	----------	1915	12,400	62,000
1899	----------	----------	1916	15,322	80,649
1900	----------	----------	1917	24,301	127,510
1901	----------	----------	1918	35,963	189,459
1902	422	2,532	1919	40,200	217,800
1903	2,703	16,015	1920	60,764	1,056,260
1904	6,950	112,282			
1905	3,000	15,000	Totals	240,232	$2,134,621

LIMESTONE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV, XV. Bulletin 38. Oregon Agr. College Extension Bulletin, 305.

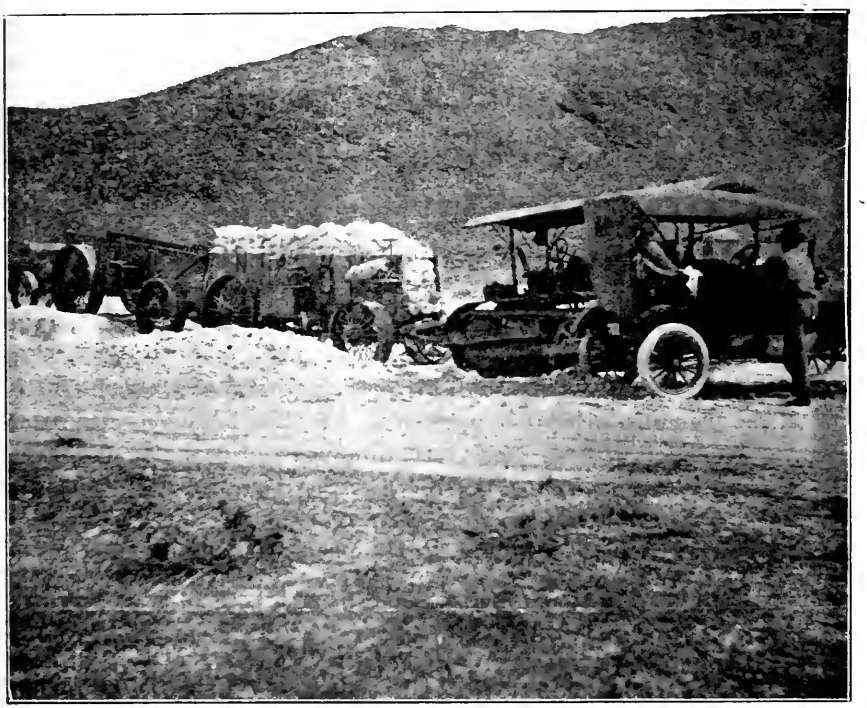
Limestone was produced in 10 counties during 1920, to the amount of 90,120 tons, valued at $298,197, being a slight increase over the 88,291 tons and $248,145 of 1919. The very considerable decrease in 1919 from 208,566 tons, valued at $456,258 in 1918, was due in part to the shutdown of the Shasta County copper smelters, which use large tonnages of limestone as flux. Those plants continued idle in 1920. The amount here given does not include the limestone used in the manufacture of cement nor of lime for building purposes, but accounts for that utilized as a smelter flux, for glass and sugar making, and in other chemical and manufacturing processes (including fertilizers, 'roofing gravel,' whiting for paint, kalsomine, terrazzo, chicken grit, and for CO_2).

In agriculture, the chief reason for the use of lime is now recognized to be that of correcting soil acidity. Lime is stated to be especially necessary for the proper development of the bacteria in the nodules on the roots of the legumes such as the clovers and alfalfa. It will also combine with some of the plant food materials already in the soil to make them more readily available, and will supply any lack of calcium as a plant food that may exist in the soil. To some extent, certain forms of lime will make heavy soils more friable, thus aiding aeration, cultivation and drainage. It may be applied, ground, in either the burned or unburned form, or as hydrated lime.

Distribution of the 1920 output is as follows:

County	Tons	Value
El Dorado	41,109	$139,873
Inyo	15,240	31,080
San Bernardino	9,300	48,150
Santa Cruz	5,062	20,101
Tuolumne	7,494	15,288
Santa Clara[a], Shasta, Siskiyou, Solano[b], Tulare*	11,915	43,705
Totals	90,120	$298,197

*Combined to conceal output of a single operator in each.
[a]Clam-shell marl, used for fertilizer.
[b]'Lime dust.'



Hauling 'whiting' (calcium carbonate) from White Boy Claim of Seipp and Merwin, on edge of Death Valley, Inyo County, California. Photo by S. R. Merwin.

In the early reports of this Bureau values for lime and limestone were not segregated. The following tabulation shows the total combined value of such material since records for the state were first compiled, in 1887, to date:

Year	Value	Year	Value
1887	$368,750	1905	$878,647
1888	381,750	1906	925,887
1889	416,780	1907	1,162,417
1890	350,000	1908	676,507
1891	300,000	1909	997,745
1892	300,000	1910	1,058,891
1893	301,276	1911	843,778
1894	337,975	1912	1,034,688
1895	457,784	1913	803,002
1896	332,617	1914	896,376
1897	291,465	1915	442,592
1898	278,558	1916	608,208
1899	343,760	1917	667,776
1900	315,231	1918	917,573
1901	434,133	1919	800,188
1902	460,140	1920	855,429
1903	582,268		
1904	658,956	Total	$20,481,147

LITHIA.

Bibliography: State Mineralogist Reports II, IV, XIV. Bulletins 38, 67.

Lithia mica, lepidolite (a silicate of lithium et al.) utilized in the manufacture of artificial mineral water, fireworks, glass, etc., has been mined in San Diego County since 1899, except between 1905 and 1915. Some amblygonite, a lithium phosphate, has also been obtained from pockets associated with the gem tourmalines. In 1919, the yield of lepidolite was 10,046 tons, valued at $153,502 from two properties, and was utilized in glass manufacture.

Lithia mica total production in the state has been as follows:

Year	Tons	Value	Year	Tons	Value
1899	124	$4,600	1915	91	$1,365
1900	440	11,000	1916	71	1,065
1901	1,160	27,500	1917	880	8,800
1902	822	31,880	1918	4,111	73,998
1903	700	27,300	1919	800	14,400
1904	641	25,000	1920	10,046	153,502
1905	25	276			
1906			Totals	15,851	$380,686

According to the U. S. Geological Survey, the only other production of lithium minerals in the United States outside of California in 1920 was spodumene from South Dakota.

MICA.

Bibliography: State Mineralogist Reports II, IV. Bulletins 38, 67.

No commercial production of mica has recently been reported in California. Production in previous years has been as follows:

Year	Tons	Value
1902	50	$2,500
1903	50	3,800
1904	50	3,000
Totals	150	$9,300

[1]"The different uses to which mica is put depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades and in insulation.

"Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo-electric machinery, electric-light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves and for making lamp chimneys and lamp shades. It is also used in spectacles, automobile shields, phonograph diaphragms, in windows where glass would be broken, and in lantern transparencies.

"Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerin in the manufacture of 'mica powder,' in tempering steel; to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings; and as a filler for various products. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts is indicated in a recent Geological Survey report.[2]

"It is understood that sheet mica has come to be of importance as a war mineral through its use abroad as windows in masks worn for defense against asphyxiating gases, and for other uses where a transparent, noninflammable, nonshattering material is necessary, as in automobile goggles and in windows for armored cars."

MINERAL PAINT.

Bibliography: State Mineralogist Reports XII, XIII, XIV, XV. Bulletin 38.

Mineral paint was produced in California in 1920 from seven mines in five counties, amounting to 779 tons, valued at $8,477. This is less than one-half the output of 1919, but an increase over the tonnage and value of 1918. There were three producers in Stanislaus County and one each in Alameda, Amador, Santa Cruz, and Ventura. There were no shipments from Colusa County in 1920. The material from Colusa is siliceous hematite, and that from Stanislaus, yellow ochre. The Calaveras and Stanislaus yellow ochre is the equal of any of the important ochres. The Santa Cruz product was magnetite concentrated from beach sands.

Besides the above-named counties, deposits of mineral paint are located in the following: Colusa, Kern, Kings, Lake, Los Angeles, Nevada, Riverside, and Sonoma.

[1]Schaller, W. T., Mica in 1916: U. S. Geol. Surv., Min. Res. of U. S., 1916, p. 304, 1917.
[2]Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite by George Steiger: U. S. Geol. Survey Bull. 620, pp. 227-235, 1916.

The first recorded production of this material in the state was in the year 1890. The output showing annual amount and value, since that time, is given herewith:

Year	Tons	Value	Year	Tons	Value
1890	40	$480	1907	250	$1,720
1891	22	880	1908	335	2,250
1892	25	750	1909	305	2,325
1893	590	26,795	1910	200	2,040
1894	610	14,140	1911	186	1,184
1895	750	8,425	1912	300	1,800
1896	395	5,540	1913	303	1,780
1897	578	8,165	1914	132	847
1898	653	9,698	1915	311	1,756
1899	1,704	26,294	1916	643	3,960
1900	529	3,993	1917	520	2,700
1901	325	875	1918	728	4,738
1902	589	1,533	1919	1,780	17,055
1903	2,370	3,720	1920	779	8,477
1904	270	1,985			
1905	754	4,025	Totals	17,226	$158,650
1906	250	1,720			

MINERAL WATER.

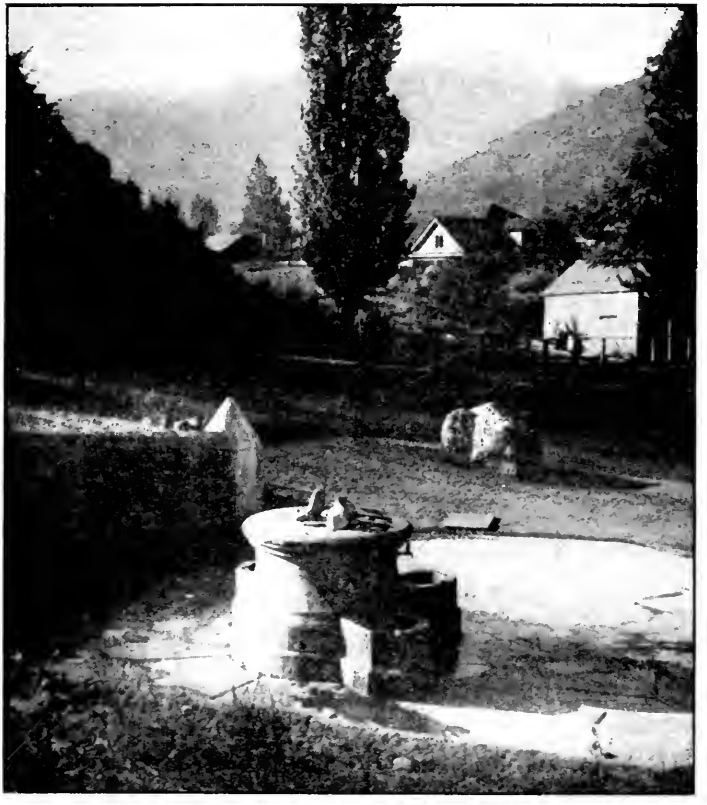
Bibliography: State Mineralogist Reports VI, XII, XIII, XIV, XV. U. S. G. S., Water Supply Paper 338.

A widespread production of mineral water is shown annually in California. These figures refer to mineral water actually bottled for sale, or for local consumption. Water from some of the springs having a special medicinal value brings a price many times higher than the average shown, while in some cases the water is used merely for drinking purposes and sells for a nominal figure. Health and pleasure resorts are located at many of the springs. The waters of some of the hot springs are not suitable for drinking, but are very efficacious for bathing. From a therapeutic standpoint, California is particularly rich in mineral springs. The counterparts of practically any of the world-famed spas of Europe or the eastern United States can be found here.

An interesting, recent development is the obtaining of 'geyser' wells at Calistoga, in Napa County, by drilling into the thermal-water strata underlying that part of the Napa Valley. There are at least four wells so erupting. They spout in true geyser fashion, and their periods vary from 10 minutes to 2 hours, each following its own schedule rather closely.

It is hoped that the State Mining Bureau will be able in the near future to make some systematic tests as to the radio-activity of the thermal waters of the hot springs of California. Some preliminary qualitative tests have been made by the writer at The Geysers in Sonoma County,

and positive reactions obtained; also, radio-activity has been proven at Arrowhead Hot Springs in San Bernardino County, by Prof. Gilbert E. Bailey of the University of Southern California.



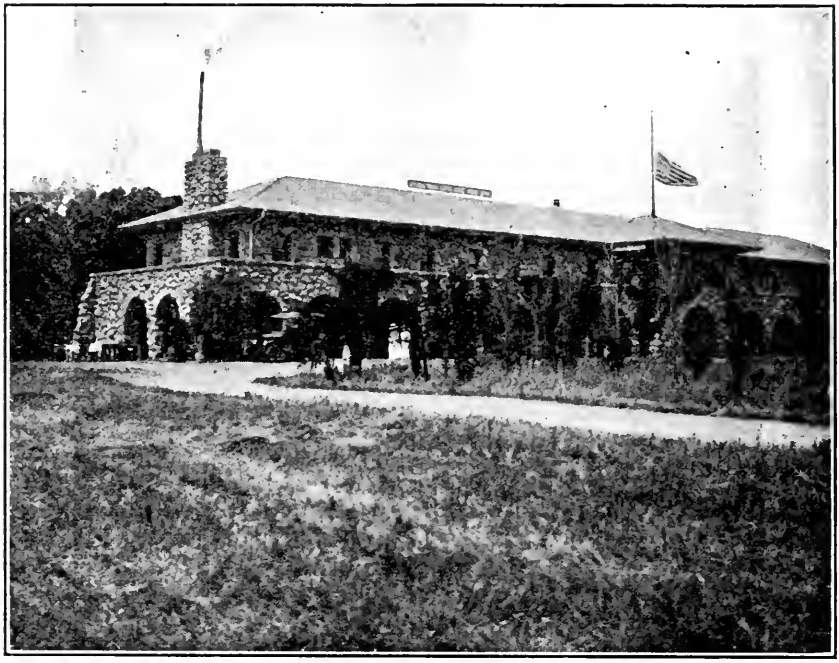
'Bartlett' spring, at Bartlett Springs, Lake County, California.

Commercial production by counties, for 1920, was:

County	Gallons	Value
Butte	6,400	$5,200
Calaveras	5,120	512
Lake	43,693	16,413
Los Angeles	161,466	10,371
Monterey	200	20
Napa	80,431	38,621
San Bernardino	1,110,190	156,726
Santa Barbara	95,843	110,931
Santa Clara	3,360	480
Siskiyou	360,150	60,015
Sonoma	29,928	6,578
Contra Costa, Humboldt, Marin, Riverside, San Benito, San Diego, Solano*	555,010	15,776
Totals	2,391,791	$421,643

*Combined to conceal output of a single operator in each.

The production above tabulated was in part bottled with artificial carbonation, in part natural, and a large part was used in the preparation of soft drinks with flavors.



Agua Caliente Springs, Sonoma County. Main building, from local trachytic tuff.

Amount and value of mineral water produced in California since 1887 are given herewith:

Year	Gallons	Value	Year	Gallons	Value
1887	618,162	$144,368	1905	2,194,150	$538,700
1888	1,112,202	252,990	1906	1,585,690	478,186
1889	808,625	252,241	1907	2,924,269	544,016
1890	258,722	89,786	1908	2,789,715	560,507
1891	334,553	139,959	1909	2,449,834	465,488
1892	331,875	162,019	1910	2,335,259	522,009
1893	383,179	90,667	1911	2,637,669	590,654
1894	402,275	184,481	1912	2,497,794	529,384
1895	701,397	291,500	1913	2,350,792	599,748
1896	808,843	337,434	1914	2,443,572	476,169
1897	1,508,192	345,863	1915	2,274,267	467,738
1898	1,429,809	213,817	1916	2,273,817	410,112
1899	1,338,537	406,691	1917	1,942,020	340,566
1900	2,456,115	268,607	1918	1,808,791	375,650
1901	1,555,328	559,057	1919	2,233,842	340,117
1902	1,701,142	612,477	1920	2,391,791	421,643
1903	2,056,340	558,201			
1904	2,430,320	496,946	Totals	57,368,888	$13,067,791

PHOSPHATES.

Bibliography: Bulletin 67.

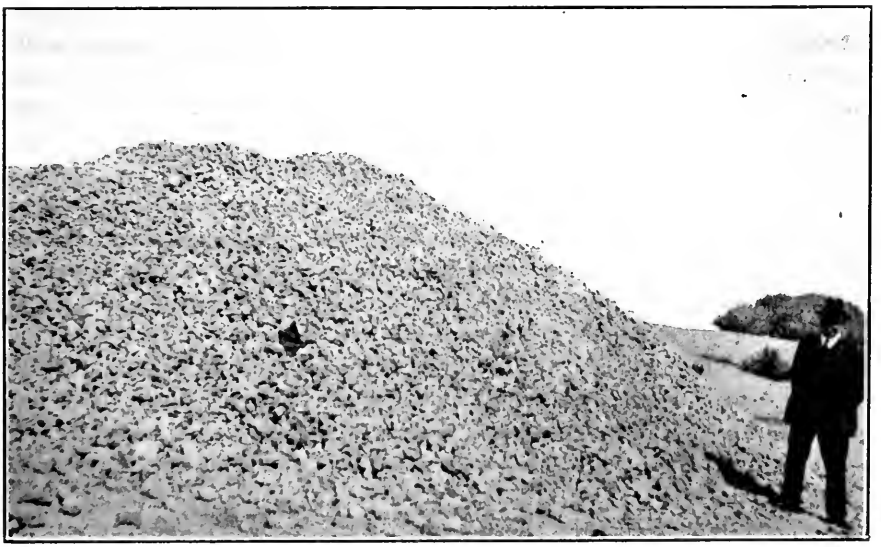
No commercial production of phosphates has been recorded from California, though occasional pockets of the lithia phosphate, amblygonite, Li (AlF) PO_4, have been found associated with the gem tourmaline deposits in San Diego County. Such production has been classified under lithia.

A deposit of phosphate rock is reported to have been located near Big Pine in Inyo, a company has been organized, and preparations are being made to develop the property.

PUMICE and VOLCANIC ASH.

Bibliography: State Mineralogist Reports XII, XIV, XV. Bulletin 38 (see 'Tufa').

The production of pumice and volcanic ash for the year 1920 amounted to 1537 tons, valued at $25,890, and came from two properties in Imperial County, and one each in Humboldt, Inyo, Napa, San Francisco, and Siskiyou counties. This is a decrease from the 2388 tons, valued at $43,657 in 1919, due mainly to the resumption of foreign importations. The material from Imperial and Siskiyou counties is the visicular, block pumice, these being practically the only localities in the United States producing this class of rock, which is stated to be the equal of the foreign article. The Lipari Islands, Italy, have in the past been the principal



Brand & Stevens' pumice, Imperial County. Thirty-ton dump of pumice, selected for grinding, awaiting shipment. Shows average size of material obtained. Photo by Emile Huguenin.

source of supply of block pumice. This form is used largely for abrasive purposes; and is also being utilized in fire-brick, and as an insulating filler in the walls of refrigerators and cold-storage plants. It is also being tried in concrete. There are other known deposits of block pumice in California, in Inyo, Madera, and Mono counties, which also contain the ash variety. The material from Humboldt, Napa, and San Francisco counties is the fine-grained, volcanic ash, or tuff variety. It is employed in making scouring soaps and polishing powders.

Commercial production of pumice in California was first reported to the State Mining Bureau in 1909, then not again until 1912, since which year there has been a small annual output, as indicated by the following table:

Year	Tons	Value	Year	Tons	Value
1909	50	$500	1916	1,246	$18,092
1910			1917	525	5,295
1911			1918	2,114	28,669
1912	100	2,500	1919	2,388	43,657
1913	3,590	4,500	1920	1,537	25,890
1914	50	1,000			
1915	380	6,400	Totals	11,980	$136,503

PYRITES.

Bibliography: Bulletin 38. Min. & Sci. Press, Vol. 114. pp. 825, 840.

Pyrite is mined for use in the manufacture of sulphuric acid, which in turn is used in large quantities in the preparation of explosives. Experiments are being made as to the effect of sulphur, sulphuric acid, and SO_2 in the correction and fertilization of alkali soils. Two properties each in Alameda and Shasta counties reported a total production in 1920 of 146,001 tons, valued at $530,581, which is a slight decrease from 1919. The material shipped carried 43% to 47% S.

This does not include the large quantities of pyrite which are otherwise treated for their valuable metal contents. Some sulphuric acid is annually made as a by-product in the course of roasting certain tonnages of Mother Lode auriferous concentrates for their precious-metal values. California has, available, supplies of sulphide ores suitable for the manufacture of sulphuric acid far in excess of the local requirements; but the excess acid if made here is not of sufficient value per ton to pay the freight rates to Eastern markets. One of our large copper smelters here could, alone, flood the market with sulphuric acid from its copper ores roasted.

The total recorded pyrite production in California to date is as follows:

Year	Tons	Value	Year	Tons	Value
1898	6,000	$36,000	1911	54,225	$182,954
1899	5,400	28,620	1912	69,872	203,470
1900	3,642	21,133	1913	79,000	218,537
1901	4,573	18,429	1914	79,267	230,058
1902	17,525	60,306	1915	92,462	293,148
1903	24,311	94,000	1916	120,525	372,969
1904	15,043	62,992	1917	111,325	323,704
1905	15,503	63,958	1918	128,329	425,012
1906	46,689	145,895	1919	147,024	540,300
1907	82,270	251,774	1920	146,001	530,581
1908	107,081	610,335			
1909	457,867	1,389,802	Totals	1,856,560	$6,277,889
1910	42,621	179,862			

SILICA—SAND and QUARTZ.

Bibliography: State Mineralogist Reports IX, XIV. Bulletins 38, 67.

We combine these materials, because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manufacture, also serves as an abrasive. Both varieties are also utilized to some extent in fire-brick manufacture.

A portion of the tonnage of vein quartz in California in 1916 and 1917 was employed in the preparation of ferro-silicon by the electric furnace. Some also is utilized as a foundry flux, and for steel casting moulds. A portion of the silica sold (both sand and quartz) is also used in glazes for porcelain, pottery and tile; and some of the sand for the preparation of sodium silicate ('water glass').

The production of silica in 1920 amounted to 25,324 tons, valued at $96,793, from thirteen properties in seven counties, distributed as follows:

County	Tons	Value
Amador	6,116	$36,432
Kern	3,060	20,100
Riverside	3,195	12,581
San Diego	7,557	18,893
Monterey, Placer*	5,396	8,787
Totals	25,324	$96,793

*Combined to conceal output of a single operator in each.

Of the above total, 7102 tons were of vein and boulder quartz, and 18,222 tons, sand.

Practically all the glass sand produced in California occurs as such and needs no grinding. There are various deposits of quartz which could

be utilized for glass making, but to date there has been only a small commercial production of this class of material.

Silica sand has been produced in the following counties of the state: Alameda, Amador, El Dorado, Los Angeles, Monterey, Orange, Placer, Riverside, San Joaquin, and Tulare. The chief producing centers have been Amador, Monterey, and Los Angeles counties. The industry is of limited importance, so far, because of the fact that much of the available material is not of a grade which will produce first-class colorless glass; for such, it must be essentially iron-free. Even a fractional per cent of iron imparts a green color to the glass.

Importations of glass sand from Belgium have again been resumed.

Total silica production in California since the inception of the industry, in 1899, is shown below, being mainly sand:

Year	Tons	Value	Year	Tons	Value
1899	3,000	$3,500	1911	8,620	$8,672
1900	2,200	2,200	1912	13,075	15,404
1901	5,000	16,250	1913	18,618	21,899
1902	4,500	12,225	1914	28,538	22,688
1903	7,725	7,525	1915	28,904	34,322
1904	10,004	12,276	1916	20,880	48,908
1905	9,257	8,121	1917	19,376	41,166
1906	9,750	13,375	1918	23,257	88,930
1907	11,065	8,178	1919	18,659	101,600
1908	9,255	22,045	1920	25,324	96,793
1909	12,259	25,517			
1910	19,224	18,265	Totals	308,490	$629,859

SOAPSTONE and TALC.

Bibliography: State Mineralogist Reports XII, XIV, XV. Bulletins 38, 67. U. S. Bur. of Mines, Rep. of Investigations, Serial No. 2253, May, 1921.

Talc—also called soapstone or steatite—occurs widely distributed throughout California. It is found as a hydration product in the alteration of magnesian silicates, and is often associated with serpentine and actinolite. A few deposits have been proven of especial value to date, and there is an undoubted future for this branch of the mineral industry in the state. Deposits of high-grade white talc, the equal of the imported Italian article, are now being developed in Inyo and San Bernardino counties. It is used in making paper, rubber, toilet articles, soap, rice polishing, lubricants, tiling, as a paint filler, etc., and for such is ordinarily ground to about 200 mesh before marketing. In this condition it brings $15 per ton and upwards, depending on quality. Some of the Inyo talc is turned and bored to various shapes for electrical insulation in such appliances as coffee percolators, heaters, and the like.

Commercially, the higher grades are called talc, and the lower, soapstone. Soapstone blocks are used in fireless cookers, electrical switchboards, laboratory table tops and laundry tubs; and the crushed material is used in roofing papers.

There was a total output in 1920 of 11,327 tons, valued at $221,362, from two producers in El Dorado, and one each in Amador, Inyo, and San Bernardino. This is an increase both in tonnage and value over the 1919 output.

Foreign importations of high-grade white talc suitable for the manufacture of toilet powder have come mainly from Canada, Italy and France. A small, irregular production of white talc was obtained from certain eastern states, but the material fluctuated in quality and quantity to such an extent that it was not largely used by manufacturers of the better-grade toilet powders. Gradually a wall of prejudice against all domestic tales grew up in the trade, and this has been fostered by people interested in the sale of the imported article.

Deposits of high-grade talc in California have been known for several years, but little interest was shown in them until 1911–1912. The lack of importations during 1917-1919, gave California an opportunity to demonstrate the quality of her goods. According to Ladoo:[1]

"In the essential qualities of pure white color, freedom from grit, and fine-grain size it is a well-established fact that the best California tales equal or surpass the best imported tales. In the debatable qualities of slip and freedom from lime some of the best California tales equal some of the best imported tales and in other cases excel other imported tales. Some of the very largest consumers of toilet-grade talc have expressed complete satisfaction with the high-grade California tales and have used them regularly in preference to Italian talc.

"Therefore, it can not be truthfully said that the United States produces no tales equal in quality to imported tales. Unfortunately many domestic consumers have been so thoroughly imbued with the alleged superiority of imported tales that domestic tales have not been given a fair chance. It is even reported that unscrupulous dealers have relabeled domestic talc and sold it as Italian talc, with perfect satisfaction to the consumers. Such dishonest trade practices are probably not common, but they serve to refute the erroneous statements regarding the quality of domestic talc."

Speaking of the Inyo Talc Company property near Keeler, in Inyo County, he states:

"This company owns three deposits of talc, two of which are being operated and the third is being prospected. The talc occurs in dolomite as lenses of irregular size and shape, but the largest lens is shaped somewhat like a boat. The talc is massive and granular, rather than fibrous or foliated, and the crude talc varies in color from a light, slate gray with a greenish tint to a pale sea green. The ground product is a clear, brilliant white. It contains practically no free silica and averages less than 1 per cent of lime (CaO). * * * Two grades of ground talc are made, the regular Raymond mill product and the product from the tubular dust collector. These are sold respectively as Sierra Snow (99.6% through 200 mesh), and Sierra Cloud (99.9% through 300 mesh). The relative proportion of the minus 300 mash product which may be obtained in this method of grinding depends upon the nature of the talc and the adjustment of the machine. When the Raymond mill or any other fine grinding machine is adjusted to give an increasingly fine product the capacity is more than proportionately reduced. Fortunately, this talc is unusually well suited to this type of grinder and an average of nearly 15 per cent of minus 300 mesh product is maintained. A greater proportion could be obtained, but at an unwarranted increase in cost."

The Pacific Coast Talc Company is also described:

"The Pacific Coast Talc Co. operates a talc mine near Silver Lake, San Bernardino County, and a grinding mill at Los Angeles. The mine is located about eight miles from the railroad and the crude ore is hauled by a 5-ton motor truck to the nearest station,

[1]Ladoo, R. B., High-grade talc and the California talc industry: U. S. Bur. of M., Reports of Investigations, Serial No. 2253, May, 1921.

Riggs, on the Tonopah & Tidewater Railroad. The crude talc is a pure, silvery white in color and has a foliated texture, somewhat resembling that from the Geo. H. Gillespie mine at Madoc, Ontario, Canada. The ground product is a very clear, silver white, with a very good slip, no grit and very little lime. A typical analysis shows 0.31% calcium oxide. The ore occurs chiefly as irregular shoots, 4 to 7 feet thick, dipping at an angle of about 57° in ferro-magnesian schist. The crude talc is very pure and practically no sorting is necessary to remove impurities."

In 1920, importations increased, due to lower ocean freight rates, cheaper foreign labor, and the condition of foreign exchange. Coupled with these, California operators are up against higher transcontinental freight rates and a very low customs import duty.

It is stated that in Italy the mines are all small tunnel workings, operated in the main by people of limited capital. Few of the companies have their own mills, the mills being separate enterprises, located at a central point, to which all the lump talc is hauled by teams. Practically all of these mines are in the northwestern corner of Italy, in the district of Pinerolo (Van Chisone), near Turin (Torino), in the province of Piedmont.

Production has been intermittent in the state since 1893, as shown in the following table:

Year	Tons	Value	Year	Tons	Value
1893	400	$17,750	1908	3	$48
1894			1909	33	280
1895	25	375	1910	740	7,260
1896			1911		
1897			1912	1,750	7,350
1898			1913	1,350	6,150
1899			1914	1,000	4,500
1900			1915	1,663	14,730
1901	10	119	1916	1,703	9,831
1902	14	288	1917	5,267	45,279
1903	219	10,124	1918	11,760	85,534
1904	228	2,315	1919	8,764	115,091
1905	300	3,000	1920	11,327	221,362
1906					
1907			Totals	46,556	$551,406

STRONTIUM.

Bibliography: Bulletin 67. U. S. G. S., Bull. 540; 660-I.

There was no production of strontium minerals in California in 1919 nor 1920, though in 1918 both celestite ($SrSO_4$), and the carbonate, strontianite ($SrCO_3$) were shipped. The first recorded commercial output of strontium minerals in California was in 1916. The occurrence of the carbonate is particularly interesting and valuable, as it appears to be the first considerable deposit of commercial importance so far opened up in the United States. Shipments reported as averaging 80% $SrCO_3$ have been made. The deposit is associated with deposits of barite., near Barstow, San Bernardino County. The carbonate has also been found in massive form near Shoshone, Inyo County. Specimens from this

deposit have recently been received and identified at the laboratory of the State Mining Bureau.

In addition to Imperial County, celestite is found near Calico and Ludlow, and in the Avawatz Mountains in San Bernardino County, but as yet undeveloped. The above noted output was converted to the nitrate.

Production of strontium minerals in California, by years, has been as follows:

Year	Tons	Value
1916	57	$2,850
1917	3,050	37,000
1918	2,900	33,000
1919		
Totals	6,007	$72,850

It is estimated by the U. S. Geological Survey, that prior to 1914 about 2000 tons of strontium nitrate was used in the manufacture of flares, or Costen and Bengal lights and fireworks. The nitrate was imported from Germany, England and Sicily.

There is a future for the strontium minerals in California, if the beet-sugar factories will take up their use, as has been done in Germany. Strontia is much more efficient and satisfactory in that process than lime, as it is stated to give an additional recovery of 6%-8% over lime. In Germany and Russia, about 100,000 tons of strontium hydroxide were used annually in the sugar industry.

Of the two minerals, strontianite is the more desirable, but scarcer. Celestite is more abundant, and can be sold at about $14–$18 per ton at the Atlantic seaboard. The carbonate during 1918 brought from $40–$50 per ton, crude, depending on quality. Celestite is found with limestones and sandstones and is sometimes associated with gypsum. Strontianite is also found with limestone, but associated with barite and calcite.

SULPHUR.

Bibliography: State Mineralogist Reports IV, XIII, XIV. Bulletins 38, 67.

There has not been, for many years, any commercial output of native sulphur in California, although this mineral has been found to some extent in Colusa, Imperial, Inyo, Kern, Lake, Mariposa, San Bernardino, Sonoma, Tehama, and Ventura counties. Operations were begun late in 1917, on a property in Inyo County, and some material stated to assay 40% sulphur was mined. Difficulties were encountered in refining it, so that only a small production was made, but none shipped.

At the Elgin mine, near Wilbur Springs, in Colusa County, a small tonnage of sulphur was prepared toward the close of 1918, but not shipped. The ore body is stated to assay 52.6% S. over a width of 22 feet. Two retorts, steam-heated, were installed, with a capacity of 4500 pounds of ore, each, per charge. There is a large body of material, in a zone at least 75 feet wide, impregnated with native sulphur crystals, which can be cheaply mined, if certain mechanical difficulties of melting and cleaning can be economically overcome.

Sulphur was produced at the famous Sulphur Bank mine, in Lake County, during the years 1865–1868 (inc.) totaling 941 tons, valued at $53,500; following which the property became more valuable for its quicksilver. The Elgin mine, noted above, is a similar occurrence.

About 37,000 tons of sulphur per year are imported to the United States from Japan, most of it coming in through the port of San Francisco. The principal sources in the United States are the stratified deposits in Louisiana and Texas, extraction being accomplished by a unique system of wells with steam pipes. It is stated that the three large companies operating there are capable of producing more than 1,000,000 tons annually in excess of our normal consumption in the United States, which averages about 600,000 tons.

Formerly considerable sulphur was imported from Italy, the Palermo district being the principal producer. The industry is under the control of the government, and exports are under license. According to a U. S. Consular Report:[1]

"Prices range from $55 to $57 for crude, to $73 to $85 for refined. As American sulphur is cheaper than Sicilian, it is believed that should freights become normal it will be possible to import American sulphur into Italy."

[1]Consular Report, Annual Series, No. 8c, Nov. 29, 1918, p. 8.

CHAPTER SIX.

SALINES.

Under this heading are included borax, common salt, soda, potash, and other alkaline salts. The first two have been produced in a number of localities in California, more or less regularly since the early sixties. Except for a single year's absence, soda has had a continuous production since 1894. Potash, and magnesium chloride and sulphate have only recently been added to the commercial list, while the nitrates are still prospective.

Our main resources of salines are the lake beds of the desert regions of Imperial, Inyo, Kern, Los Angeles, San Bernardino, San Luis Obispo, and Siskiyou counties, and the waters of the Pacific Ocean.

The following tabulation shows amount and value of the saline minerals produced in California during the years 1919 and 1920, with increase or decrease in value for 1920, as compared with the previous year:

Substance	1919		1920		Increase + Decrease— Value
	Tons	Value	Tons	Value	
Borax	66,791	$1,717,192	127,065	$2,794,206	$1,077,014+
Magnesium salts	1,616	82,457	3,150	107,787	25,330+
Potash	28,118	2,415,963	26,298	1,465,463	950,500—
Salt	233,994	896,963	230,628	972,648	75,685+
Soda	21,294	721,958	32,407	1,164,898	442,940+
Total value		$5,834,533		$6,505,002	
Net increase					$670,469

BORAX.

Bibliography: State Mineralogist Reports III, X, XII, XIII, XIV, XV. Bulletins 24, 67.

Borax was first discovered in California in the waters of Tuscan Springs in Tehama County, January 8, 1856. Borax Lake, in Lake County, was discovered in September of the same year by Dr. John A. Veatch. This deposit was worked in 1864–1868, inclusive, and during that time produced 1,181,365 pounds of refined borax. This was the first commercial output of this salt in the United States, and California is still today the only American producer of borax.

Production from the dry lake 'playa' deposits of Inyo and San Bernardino counties began in 1873; but it was not until 1887 that the borax industry was revolutionized by the discovery of the colemanite beds at Calico in San Bernardino County. These have since been worked

out, and the output for a number of years has been coming from similar beds in Inyo and Los Angeles counties. In 1920 San Bernardino County again entered the field with shipments of such ore from near Daggett. The colemanite deposits of Ventura County are at present unworked, owing to lack of transportation facilities.

During 1920 there was reported a total output of 127,065 tons, valued at $2,794,206, compared with 66,791 tons, valued at $1,717,192 in 1919. As in 1919, this also includes some refined borax made from the brine of Searles Lake in San Bernardino County.

Colemanite is a calcium borate, and the material mined is mostly shipped to eastern chemical plants for refining. Refined 'borax' (sodium tetraborate) is used in making the enameled coating for cast-iron and steel-ware employed in plumbing fixtures, chemical equipment, and kitchen utensils. It is also a constituent of borosilicate glasses which are utilized in making lamp chimneys, baking dishes, and laboratory glassware. Other important uses of borax are in the manufacture of laundry and kitchen soaps, in starch, paper sizing, tanning, welding, and in the preparation of boric acid, which is employed as an antiseptic and in preserving meats.

The total production of borax in California is shown in the following table:

Year	Tons	Value	Year	Tons	Value
1864	12	$9,478	1894	5,770	$807,807
1865	126	94,099	1895	5,959	595,900
1866	201	132,538	1896	6,754	675,400
1867	220	156,137	1897	8,000	1,080,000
1868	32	22,384	1898	8,300	1,153,000
1869	----------	----------	1899	20,357	1,139,882
1870	----------	----------	1900	25,837	1,013,251
1871	----------	----------	1901	22,221	982,380
1872	140	89,600	1902	[a]17,202	2,234,994
1873	515	255,440	1903	34,430	661,400
1874	915	259,427	1904	45,647	698,810
1875	1,168	289,080	1905	46,334	1,019,158
1876	1,437	312,537	1906	58,173	1,182,410
1877	993	193,705	1907	53,413	1,200,913
1878	373	66,257	1908	22,200	1,117,000
1879	364	65,443	1909	16,628	1,163,960
1880	609	149,245	1910	16,828	1,177,960
1881	690	189,750	1911	50,945	1,456,672
1882	732	201,300	1912	42,135	1,122,713
1883	900	265,500	1913	58,051	1,491,530
1884	1,019	198,705	1914	62,500	1,483,500
1885	942	155,430	1915	67,004	1,663,521
1886	1,285	173,475	1916	103,523	2,409,375
1887	1,015	116,689	1917	109,944	2,561,958
1888	1,405	196,636	1918	88,772	1,867,908
1889	965	145,473	1919	66,791	1,717,192
1890	3,201	480,152	1920	127,065	2,794,206
1891	4,267	640,000			
1892	5,525	838,787	Totals	1,223,789	$42,763,359
1893	3,955	593,292			

[a]Refined borax.

MAGNESIUM SALTS.

Magnesium chloride is an important item in certain chemical uses, and in the preparation of Sorel cement in laying magnesite floors. Previous to 1915, Germany was the principal source of this chloride, which source was, of course, cut off during the war. Some of the salt companies in California began its commercial preparation in 1916, from the residual bitterns obtained during the evaporation of sea water for its sodium chloride. Also experiments have been made to prepare it by acid solution from magnesite which is so abundant in California.

In addition to the chloride, some magnesium sulphate, or 'technical epsom salts,' has also been made at four of the plants: Oliver Chemical Company in Alameda County, Whitney Chemical Company in San Mateo County, the Marine Chemical Company at Long Beach, Los Angeles County, and the California Chemical Company at San Diego; though but two of them reported sales of the sulphate in 1920. In 1919, the Merle Magnesia Company at Redwood City, San Mateo County, produced magnesium carbonate for use in magnesia-asbestos pipe covering. In 1920, the average price reported for chloride was $35 per ton, and the sulphate at $40 to $60 per ton.

The 1920 output of chloride and sulphate totaled 3150 tons, valued at $107,787, from Alameda, Los Angeles, San Diego and San Mateo counties, compared with 1616 tons and $82,457 in 1919. The chloride was utilized in Sorel cement for flooring and stucco; the sulphate, for tannery and medical purposes.

With the use of magnesite cement and stucco coming more and more into vogue, the demand for magnesium chloride will increase in proportion. It is destined to become an important industry.

Bitterns made at plants on San Francisco Bay carry 23 to 86 parts of magnesium per thousand, or 2.3% to 8.6% magnesium.[1]

Metallic magnesium is prepared electrolytically, utilizing generally an electrolyte of magnesium chloride and an alkaline chloride. Its commonest known use is in the powdered form for flash lights in photography. During the war, magnesium was put in shrapnel shells, that observers and gunners might know exactly where the shells were bursting. By day the burning magesium gives a dense pure-white cloud of magnesium oxide, and at night a dazzling white light. Larger quantities were used in aerial bombs and rockets for lighting up the country at night. Magnesium has as yet found but a limited direct use as a metal. Magnalium, an alloy of aluminum containing about 2% of magnesium and small percentages of other metals, is stated to be used in automobiles and aeroplanes. The possibilities for further important developments in this direction are promising.

[1]U. S. Dept. Agr. Bur. Soils, 94, p. 66, 1913.

The total production of magnesium salts in California since the beginning of the industry here, is shown in the following tabulation:

Year	Tons	Value
1916	851	$6,407
1917	1,064	34,973
1918	1,008	29,955
1919	1,616	82,457
1920	3,150	107,787
Totals	7,689	$261,579

NITRATES.

Bibliography: Report XV. Bulletin 24. U. S. G. S., Press Bulletin No. 373, July, 1918.

Nitrates of sodium, potassium and calcium have been found in various places in the desert regions of the state, but no deposit of commercial value has been developed as yet. It is hoped that a closer search may some day be rewarded by workable discoveries. At present the principal commercial source of nitrates is the Chilean saltpeter (sodium nitrate) deposits in South America.

The fixation of atmospheric nitrogen electrically has been accomplished successfully in Germany and Scandinavia. The possibilities of cheap hydro-electric power in California make the subject one of intense interest to us, as we have also the natural raw materials and chemicals to go with the power. Sodium and potassium cyanides can be made by fixation of atmospheric nitrogen electrically.

POTASH.

Bibliography: Report XV. Bulletin 24. U. S. G. S., Min. Res. 1913, 1914, 1915. Senate Doc. No. 190, 62d Congress, 2d Session. Mining & Sci. Press, Vol. 112, p. 155; Vol. 114, p. 789.

Potash production began commercially in California in 1914, with a small yield from kelp. Considerable time and money has been spent on research work incident to developing deposits of potash-bearing residues and brines in the old lake beds of the desert regions, and production there is now on a commercial basis at two plants on Searles Lake. A third plant is preparing for production.

The imports of potash salts and fertilizers from Germany previous to the European war had an annual value of several millions of dollars, and their cessation made a domestic production imperative.

The normal pre-war price of $35 to $40 per ton for high-grade agricultural salts has been succeeded by figures of several times those amounts, so that in April, 1916, the chloride was nominally quoted at

$425 per ton and the sulphate from $350 to $400 per ton. The selling price in 1920 at point of shipment for potash materials ranged from $1.40 to $2.50 per unit, corresponding to $140 to $250 per ton of 100% K_2O.

During 1920, a total of 26,298 tons of potash-bearing materials of all grades was produced in California, valued at $1,465,463. This is a decrease both in tonnage and value from the 1919 output. The outlook for the future is very uncertain on account of the resumption of foreign importations.

The 1920 product included refined potassium chloride and kelp ash; refined sulphate from one of the cement mills; concentrated salts from the brine of Searles Lake; also potash char from molasses distillery waste and Steffens waste water in beet-sugar manufacture. An important tonnage of potash char was produced at one plant operating on Hawaiian molasses, but which is not included herein, not being of California origin. A small tonnage of crude natural salts from a spring deposit was shipped from Siskiyou County.

Small tonnages of refined chloride were also made from bitterns at two of the salt plants on San Francisco Bay. No yield from kelp was made in 1919 or 1920 in Los Angeles County. The government kelp plant at Summerland, Santa Barbara County, also recovers some iodine as a by-product.

The bulk of this potash output was utilized in fertilizer preparations; and some was sold for chemical purposes.

Other uses for potash salts besides those noted above, are in the manufacture of the best liquid soap and some higher-grade cake soaps, of some finer grades of glass, and in matches. The chemical requirements include tanning, dyeing, metallurgy, electroplating, photography, and medicine.

The large plant of the American Trona Corporation at Trona, on Searles Lake, San Bernardino County, began commercial operation in September, 1916, and ships chloride of potash to Eastern fertilizer works. Their product carries the equivalent of 58% K_2O. A second plant at Searles Lake, built by the Solvay Process Company, began commercial operation in 1917. Their product, also high-grade, is KCl. A third plant has been built by the West End Mining Company, but did not ship any material in 1920.

In the cement mill of the Riverside Portland Cement Company, the fine dust from ball and tube mills is collected by a Cottrell electrical fume precipitator, the material showing a potash content. Sulphate has been prepared from this. Other cement plants, in San Bernardino and Santa Cruz counties, have also made some recovery of potash from flue dust.

The following tabulation shows the distribution of the 1920 output of potash in California:

County	Product	Equivalent per cent K_2O	Tons	Value
San Bernardino	Chloride	52–58	15,435	$1,082,037
Santa Barbara	Chloride	50	410	40,000
Alameda, Orange, Riverside, San Mateo, Santa Clara, Santa Cruz, Siskiyou*	Chloride, sulphate, molasses distillery slops char, Steffens water char, crude natural salts, cement dust	3–46	10,453	343,426
Totals			26,298	$1,465,463

*Combined to conceal output of a single operator in each.

The annual amounts and values of these potash materials since their beginning in California in 1914, are shown by the following table:

Year	Tons	Value
1914	10	$460
1915	1,076	19,391
1916	17,908	663,605
1917	129,022	4,202,889
1918	49,381	6,808,976
1919	28,118	2,415,963
1920	26,298	1,465,463
Totals	251,813	$15,576,747

SALT.

Bibliography: State Mineralogist Reports II, XII XIII, XIV, XV. Bulletin 24.

Most of the salt produced in California is obtained by evaporating the waters of the Pacific Ocean, plants being located on the shores of San Francisco Bay, at Long Beach, and on San Diego Bay. Additional amounts are derived from lakes and lake beds in the desert regions of the state. The salt production of San Bernardino County is mainly derived from deposits of rock salt which are worked by means of quarrying and steam shovels. A small amount of valuable medicinal salts is occasionally obtained in Mono and Tehama counties, by evaporation from Mono Lake and mineral springs respectively.

Formerly a considerable proportion of the table salt consumed in California was shipped in from Eastern points; but, at present, California salt refineries supply not only our own needs but export a fair tonnage to other markets.

It may appear, at first thought, superfluous to enumerate the uses of so well-known an item as 'common' salt, one whose history antedates the written page; but it is employed for many purposes other than culinary. A recent press bulletin of the U. S. Geological Survey states that there was produced in the United States in 1920 sufficient salt to supply each one of the 106,000,000 inhabitants with 150 pounds apiece. Besides its culinary uses, salt is employed in packing meat, curing fish and hides, dairying, refrigerating, preserving products from deterioration, pottery glazing, enameling, pickle making, salting live stock, and in some chemical industries, as in preparing soda ash and caustic soda.

Salt deposit of Pacific Rock Salt Company, near Amboy, San Bernardino County. Showing bed of 8 feet of rock salt. Photo by W. B. Tucker.

Distribution of the 1920 production of California, by counties, was as follows:

County	Tons	Value
Alameda	145,368	$574,837
Kern	22,000	87,000
Los Angeles	6,502	6,577
San Bernardino	[b]202	1,220
San Diego	15,300	77,100
San Mateo	37,409	206,897
Inyo, Modoc, Mono[a], Monterey	3,857	19,017
Totals	230,638	$972,648

[a]Medicinal salts.
[b]Medicinal salts and rock salt.

The above returns show a slight decrease in tonnage but an increase in value, as compared to 1919. There were 12 plants operating in Alameda, and a total of 14 plants in other counties tabulated.

Amount and value of annual production of salt in California from 1887 is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	28,000	$112,000	1905	77,118	$141,925
1888	30,800	92,400	1906	101,650	213,228
1889	21,000	63,000	1907	88,063	310,967
1890	8,729	57,085	1908	121,764	281,469
1891	20,094	90,363	1909	155,680	414,708
1892	23,570	104,788	1910	174,920	395,417
1893	50,500	213,000	1911	173,332	324,255
1894	49,131	140,087	1912	185,721	383,370
1895	53,031	150,576	1913	204,407	462,681
1896	64,743	153,244	1914	223,806	583,553
1897	67,851	157,520	1915	169,028	368,737
1898	93,421	170,855	1916	186,148	455,695
1899	82,654	149,588	1917	227,825	584,373
1900	89,338	204,754	1918	212,076	806,328
1901	126,218	366,376	1919	233,994	896,963
1902	115,208	205,876	1920	230,638	972,648
1903	102,895	211,365			
1904	95,968	187,300	Totals	3,889,321	$10,426,434

SODA.

Bibliography: State Mineralogist Reports XII, XIII, XV. Bulletins 24, 67.

The production of the carbonates and sulphate of sodium, in California in 1920, included soda ash from plants at Owens Lake, the natural sulphate from the Carrizo Plains, San Luis Obispo County, and a natural sulphate from a deposit in San Bernardino County. The total tonnage was 32,407, valued at $1,164,898, the bulk of which came from the three plants in Inyo County. This is the largest yield of any year since the beginning of this industry in California.

These 'sodas' were used in the manufacture of glass, soap, and paper, as well as washing and baking soda, in sugar refining, and in various chemical industries. A portion of the product was exported. The export demand was quite active during 1920, up to November, when it fell off sharply.

The war stimulated the chemical industry in the United States to produce materials that were formerly imported and to supply them to foreign countries, as well as to devise new uses for chemical products, also to replace more expensive by less expensive chemicals. Sodium compounds have replaced potassium compounds, either wholly or in part, in glass and soap making, in photography, in match making, in tanning, and in the manufacture of cyanide for extracting gold and silver from their ores.

The total output, showing amount and value of these materials in California since the inception of the statistical records of the State Mining Bureau, is given in the table which follows:

Year	Tons	Value	Year	Tons	Value
1894	1,530	$20,000	1909	7,712	$11,593
1895	1,900	47,500	1910	8,125	11,862
1896	3,000	65,000	1911	9,023	52,887
1897	5,000	110,000	1912	7,200	37,094
1898	7,000	154,000	1913	1,861	24,936
1899	10,000	250,000	1914	6,522	115,396
1900	1,000	50,000	1915	5,799	83,485
1901	8,000	400,000	1916	10,593	264,825
1902	7,000	50,000	1917	24,505	928,578
1903	18,000	27,000	1918	20,447	855,423
1904	12,000	18,000	1919	21,294	721,958
1905	15,000	22,500	1920	32,407	1,164,898
1906	12,000	18,000			
1907			Totals	266,518	$5,519,335
1908	9,600	14,400			

CHAPTER SEVEN.

MINERAL PRODUCTION OF CALIFORNIA BY COUNTIES.

Introductory.

The State of California includes a total area of 158,360 square miles, of which 155,980 square miles are of land. The maximum width is 235 miles, the minimum, 148 miles; and the length from the northwest corner to the southeast corner is 775 miles. The state is divided into fifty-eight counties. Some mineral of commercial value exists in every county, and during 1920 some active production was reported to the State Mining Bureau from all of the fifty-eight. In the mountainous portions of the state are largely found the vein-forming minerals. In the desert regions of southeastern California ancient lake beds afford supplies of saline deposits. Underlying the interior valleys of the central and southern portion of the state are the large crude oil reservoirs. Building stones and mineral earths of all descriptions are widely distributed throughout the length and breadth of the state. The 1920 census figures show a total population for California of 3,437,709.

Of the first ten counties in point of total output for 1920, the first five (Kern, Orange, Los Angeles, Fresno, Santa Barbara) owe their position mainly to petroleum, as does also Ventura (seventh). Kern, due to its oil, leads all the others by over two and one-half times the total of Orange, its nearest competitor. San Bernardino owes its place to cement, silver and potash; Riverside, to gold; Inyo, mainly to borax, soda, lead, and silver; and Yuba mainly to gold. Twenty-two counties have each a total in excess of a million dollars, for 1920. Cement is an important item in six of these counties.

In point of variety and diversity, San Bernardino County led all the others in 1920 with a total of 22 different mineral products on its commercial list, followed by Los Angeles with 19, Kern with 16, and Inyo, Riverside, San Diego, and Shasta with 15 each.

The counties with their mineral resources, production for 1920, etc., are considered in detail in this chapter.

Value of California Mineral Production by Counties, for 1920, Arranged in the Order of Their Importance.

County	Value	County	Value
1. Kern	$89,121,581	31. San Luis Obispo	405,604
2. Orange	31,108,136	32. Stanislaus	385,017
3. Los Angeles	26,975,163	33. Marin	335,745
4. Fresno	23,819,351	34. San Mateo	293,103
5. Santa Barbara	10,538,611	35. Sonoma	287,245
6. San Bernardino	6,541,348	36. Mariposa	271,031
7. Ventura	5,229,175	37. Napa	230,141
8. Riverside	5,128,208	38. Siskiyou	229,115
9. Inyo	3,889,400	39. Mono	188,258
10. Yuba	3,573,649	40. El Dorado	186,432
11. Santa Cruz	3,081,138	41. Imperial	169,882
12. Nevada	2,955,066	42. Humboldt	159,796
13. Solano	2,930,614	43. Glenn	134,707
14. Plumas	2,082,662	44. Monterey	126,449
15. Contra Costa	2,082,053	45. Madera	122,925
16. Sacramento	2,066,154	46. San Francisco	80,353
17. Amador	2,010,200	47. Lake	63,553
18. Alameda	1,947,880	48. Colusa	57,488
19. Calaveras	1,880,050	49. Kings	29,870
20. San Benito	1,483,024	50. Tehama	26,400
21. Shasta	1,108,538	51. Mendocino	26,110
22. Santa Clara	1,038,692	52. Merced	24,800
23. San Diego	794,229	53. Lassen	12,313
24. Butte	641,562	54. Del Norte	11,781
25. Placer	612,813	55. Yolo	9,472
26. Tulare	593,296	56. Modoc	4,668
27. Trinity	562,105	57. Alpine	840
28. Tuolumne	513,914	58. Sutter	54
29. San Joaquin	471,102		
30. Sierra	446,861	Total	$242,099,667

ALAMEDA.

Area: 843 square miles.

Population: 344,177 (1920 census).

Alameda County, while in no sense one of the "mining counties," comes eighteenth on the list with a value of mineral products for 1920 of $1,947,880, an increase from the 1919 total, which was $1,304,685. The mineral resources of this county include asbestos, brick, chromite, clay, coal, limestone, magnesite, manganese, pyrite, salt, soapstone, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick and tile		$664,918
Clay (pottery)	3,001 tons	3,762
Pyrites	10,602 tons	55,251
Salt	145,368 tons	574,837
Stone, miscellaneous		620,758
Other minerals*		28,354
Total value		$1,947,880

*Includes magnesium salts, manganese, mineral paint, and potash.

ALPINE.

Area: 776 square miles.
Population: 243 (1920 census).

Alpine has in the past shown a small production of gold and silver, but dropped out of the list of producing counties in 1914–1918. For 1920, a total value of $840 was reported, distributed as follows:

Substance	Amount	Value
Stone, miscellaneous		$680
Other minerals*		160
Total value		$840

*Includes gold and silver.

This county lies just south of Lake Tahoe, in the high Sierra Nevada range of mountains. Transportation is by wagon or mule back, and facilities in general are lacking to promote development work of any kind.

The mineral resources of this section are varied and the country has not yet been thoroughly prospected. Occurrences of barium, copper, gold, gypsum, lead, limestone, pyrite, rose quartz, silver, tourmaline, and zinc have been noted here.

AMADOR.

Area: 601 square miles.
Population: 7,793 (1920 census).

The value of Amador County's mineral production decreased from $3,173,588 in 1919 to $2,010,200, placing it number seventeen on the list of counties in the state as regards total value of mineral substances marketed. The drop was due to a decrease in gold output.

Although having an output consisting of 10 different minerals, the leading product, gold, makes up approximately 89% of the entire total. Amador at one time led the state in gold production, but was exceeded in 1920 by Yuba and Nevada counties.

The mineral resources of this county include asbestos, brick, chromite, clay, coal, copper, gold, lime, quartz crystals, glass-sand, sandstone, silver, soapstone, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Clay (pottery)	25,719 tons	$61,808
Gold		1,788,793
Silver		19,780
Silica	6,116 tons	36,432
Stone		680
Other minerals*		102,707
Total value		$2,010,200

*Includes brick, coal, mineral paint, platinum, and soapstone.

BUTTE.

Area: 1,722 square miles.
Population: 30,030 (1920 census).
Location: North-central portion of state.

Butte, twenty-fourth county in California in regard to the value of its mineral output, reported a commercial production of seven mineral substances, having a total value of $641,562 as compared with $481,537. As will be noted in the following tabulation, gold is by far the most important item. Butte stands seven among the gold-producing counties of the state. Among the mineral resources of this section are asbestos, barytes, chromite, gems, gold, limestone, marble, mineral water, platinum minerals, silver and miscellaneous stone.

Commercial value for 1920 was as follows:

Substance	Amount	Value
Gems		$400
Gold		467,900
Mineral water	6,400 gals.	5,200
Platinum	42 fine oz.	4,714
Silver		2,253
Other minerals*		161,095
Total value		$641,562

*Includes natural gas and miscellaneous stone.

CALAVERAS.

Area: 1,027 square miles.
Population: 6,183 (1920 census).
Location: East-central portion of state—Mother Lode district.

Calaveras County reported production of 8 different minerals, valued at $1,880,050 during the year 1920, as compared with the 1919 output at $1,978,558. Gold, copper, and silver are the chief mineral substances produced. In regard to total value of mineral output Calaveras stands nineteenth among the counties of the state; it is fifth in gold, second in copper, eighth in silver, having been passed by Plumas in copper and silver output for 1918–1920, and by Kern in silver, 1919–1920. The decrease, as compared with 1919, is due to gold and copper.

The principal mineral resources developed and undeveloped are: Asbestos, chromite, clay, copper, fuller's earth, gold, limestone, marble, mineral paint, mineral water, platinum minerals, pyrite, quartz crystals, silver, soapstone, and miscellaneous stone.

Commercial output for 1920 was as follows:

Substance	Amount	Value
Copper	2,112,186	$388,642
Gold		1,439,745
Mineral water	5,120 gals.	512
Platinum	20 fine oz.	2,002
Silver		16,701
Stone, miscellaneous		2,400
Other minerals*		30,048
Total value		$1,880,050

*Includes gem material and lead.

COLUSA.

Area: 1,140 square miles.
Population: 9,920 (1920 census).
Location: Sacramento Valley.

Colusa County lies largely in the basin of the Sacramento Valley. Its western border, however, rises into the foothills of the Coast Range of mountains, and its mineral resources—largely undeveloped—include coal, chromite, copper, gypsum, manganese, mineral water, pyrite, quicksilver, sandstone, miscellaneous stone, sulphur, and in some places traces of gold and silver.

The value of the 1920 production was $57,488, an increase over the 1919 figures of $7,300, giving it forty-eighth place.

CONTRA COSTA.

Area: 714 square miles.
Population: 53,889 (1920 census).

Contra Costa, like Alameda County, lies on the eastern shores of San Francisco Bay, and is not commonly considered among the mineral-producing counties of the state. It stands fifteenth on the list in this respect, however, with an output valued at $2,082,053 for the calendar year 1920. Various structural materials make up the chief items, including brick, cement, limestone, and miscellaneous stone. Among the others are asbestos, clay, coal, gypsum, manganese, mineral water, and soapstone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick	13,608 M.	$312,398
Clay (pottery)	1,743 tons	3,319
Stone, miscellaneous		432,654
Other minerals*		1,333,682
Total value		$2,082,053

*Includes cement and mineral water.

DEL NORTE.

Area: 1,024 square miles.
Population: 2,759 (1920 census).
Location: Extreme northwest corner of state.
Transportation: Wagon and mule back; steamer from Crescent City.

Del Norte rivals Alpine County in regard to inaccessibility. Like the latter county also, given transportation and kindred facilities, this portion of the state presents a wide field for development along mining lines especially. Its chief mineral resources, largely untouched, are chromite, copper, gems, gold, iron, platinum minerals, silver, and miscellaneous stone. The 1920 output was an increase over the figure of $7,240 in 1919.

Commercial production for 1920, giving it fifty-fourth place, was as follows:

Substance	Amount	Value
Stone, miscellaneous		$9,000
Other minerals*		2,781
Total value		$11,781

*Includes chromite and copper.

EL DORADO.

Area: 1,753 square miles.
Population: 6,426 (1920 census).
Location: East-central portion of the state, northernmost of the Mother Lode counties.

El Dorado County, which contains the locality where gold in California was first heralded to the world, comes fortieth on the list of counties ranked according to the value of their total mineral production during the year 1920. In addition to the segregated figures here given, a large tonnage of limestone is annually shipped from El Dorado for use in cement manufacture, and whose value is included in the state total for cement. The increase over the 1919 figure of $166,152 was due mainly to limestone.

The mineral resources of this section, many of them undeveloped, include asbestos, barytes, chromite, clay, copper, gems, gold, iron, molybdenum, limestone, quartz crystals, quicksilver, glass-sand, slate, soapstone, silver and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Gold		$13,379
Limestone	41,109 tons	139,873
Silver		155
Soapstone	2,640 tons	18,200
Stone, miscellaneous		5,500
Other minerals		9,325
Total value		$186,432

FRESNO.

Area: 5,950 square miles.
Population: 128,779 (1920 census).
Location: South-central portion of state.

Fresno County, fourth in importance as a mineral producer among the counties of California, reported an output for 1920 of ten mineral substances, with a total value of $23,819,351, an increase over the reported 1919 production, which was worth $21,664,465. The great bulk of the above is derived from the petroleum production of the Coalinga field.

The mineral resources of this county are many, and, aside from crude oil, are in the main not yet fully developed. They include asbestos, barytes, brick, chromite, copper, gems, gold, graphite, gypsum, magnesite, natural gas, petroleum, quicksilver, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick	12,517 M.	$196,756
Gold		7,793
Granite		49,600
Magnesite	906 tons	8,725
Natural gas	3,721,313 M. cu. ft.	201,865
Petroleum	15,375,454 bbl.	22,801,798
Silver		227
Stone, miscellaneous		535,587
Other minerals		17,000
Total value		$23,819,351

GLENN.

Area: 1,259 square miles.
Population: 11,853 (1920 census).
Location: West side of Sacramento Valley.

Glenn County, standing forty-third, owes its position among the mineral-producing counties of the state mainly to the presence of large deposits of sand and gravel which are annually worked, the product being used for railroad ballast, etc. In 1917 and 1918, chromite was

also an important item. In the foothills in the western portion of the county, deposits of chromite, copper, manganese, sandstone, and soapstone have been found.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$134,707

HUMBOLDT.

Area: 3,634 square miles.

Population: 37,857 (1920 census).

Location: Northwestern portion of state, bordering on Pacific Ocean.

Humboldt County is almost entirely mountainous, transportation within its limits being very largely by wagon road and trail, and until recent years was reached from the outside world by steamer only. The county is rich in mineral resources, among which are brick, chromite, coal, clay, copper, gold, iron, mineral water, natural gas, petroleum, platinum, silver and miscellaneous stone.

Ten mineral substances, as shown by the table given below, having a total value of $159,796, were produced in 1920, as compared with the 1919 output, worth $52,011, the increase being due to manganese. Humboldt ranks forty-second among the counties of the state for the year.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Gold		$2,538
Manganese	859 tons	18,513
Silver		19
Stone, miscellaneous		133,290
Other minerals*		5,436
Total value		$159,796

*Includes brick, clay, granite, mineral water, natural gas and volcanic ash.

IMPERIAL.

Area: 4,089 square miles.

Population: 43,383 (1920 census).

Location: Extreme southeast corner of the state.

During 1920 Imperial County produced five mineral substances having a total value of $169,882, as compared with the 1919 output, worth $140,443. Its rank is forty-first. This county contains deposits of gold, gypsum, lead, marble, pumice, salt, silver, and strontium, largely undeveloped.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Pumice	624 tons	$16,500
Silver		2,183
Stone, miscellaneous		127,412
Other minerals		23,787
Total value		$169,882

INYO.

Area: 10,019 square miles.

Population: 7,031 (1920 census).

Location: Lies on eastern border of state, north of San Bernardino County.

Inyo, the second largest county in the state, and containing less than one inhabitant per square mile, is extremely interesting from a mineralogical point of view. It is noted because of the fact that within its borders are located both the highest point, Mount Whitney (elevation 14,502 feet), and the lowest point, Death Valley (elevation 290 feet below sea level), in the United States. In the higher mountainous sections are found many vein-forming minerals, and in the lake beds of Death Valley saline deposits exist.

Inyo's mineral production during the year 1920 reached a value of $3,889,400, standing ninth among the counties of the state in this respect. The 1919 value was $2,692,546, the increase being due mainly to borax, lead, and silver. Its mineral resources include antimony, asbestos, barytes, borax, copper, gems, gold, gypsum, lead, marble, soda, sulphur, talc, tungsten, and zinc.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Copper	144,286 lbs.	$26,549
Gold		55,634
Lead	4,612,338 lbs.	368,987
Limestone	15,240 tons	31,080
Silver		258,929
Soda	23,132 tons	933,023
Stone, miscellaneous		1,190
Other minerals*		2,214,008
Total value		$3,889,400

*Includes borax, dolomite, fuller's earth, marble, volcanic ash, salt, talc, and zinc.

KERN.

Area: 8,003 square miles.
Population: 54,843 (1920 census).
Location: South-central portion of state.

Kern County, because of its immensely productive oil fields, stands pre-eminent among all counties of California in the value of its mineral output, the exact figures for 1920 being $89,121,581. This is larger by more than fifty million dollars than the succeeding county on the list. This figure also is nearly six and one-half times the value of the total gold output of the entire state for 1920. The 1919 mineral output for Kern County was worth $66,625,352. The increase was due to the enhanced prices for crude oil of all grades.

Among the mineral resources, developed and undeveloped, of this section are: Antimony, asphalt, borax, brick, clay, copper, fuller's earth, gems, gold, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, natural gas, petroleum, potash, salt, silver, soapstone, soda, sulphur and tungsten.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick	3,850 M.	$56,550
Copper	206 lbs.	38
Gold		61,187
Lime	76,395 bbls.	106,733
Natural gas	34,912,865 M. cu. ft.	1,810,147
Petroleum	50,660,438 bbls.	86,831,991
Salt	22,000 tons	87,000
Silver		8,385
Silica	3,060 tons	20,100
Stone, miscellaneous		31,180
Other minerals*		108,270
Total value		$89,121,581

*Includes cement, gems, lead, and quicksilver.

KINGS.

Area: 1,159 square miles.
Population: 22,031 (1920 census).
Location: South-central portion of the state.

Little development has taken place in Kings County along mineral lines to date. Deposits of fuller's earth, gypsum, mineral paint, natural gas, and quicksilver, of undetermined extent, have been found in the county. Some drilling for oil has been under way, but there has, as yet, been no commercial output recorded. The decrease in 1920 was due to quicksilver.

In forty-ninth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Natural gas	2,765 M. cu. ft.	$1,250
Quicksilver	436 flasks	28,620
Total value		$29,870

LAKE.

Area: 1,278 square miles.
Population: 5,542 (1920 census).
Location: About fifty miles north of San Francisco Bay and the same distance inland from the Pacific Ocean.

On account of its topography and natural beauties, Lake County is sometimes referred to as the Switzerland of America. The mineral resources which exist here are many and varied, actual production being comparatively small, as shown by the table below, and composed mainly of quicksilver, and mineral water. Some of the leading minerals found in this section, in part as yet undeveloped, are borax, chromite, clay, copper, gems, gold, gypsum, mineral water, quicksilver, silver, and sulphur.

In forty-seventh place, commercial production for 1920 was as follows:

Substance	Amount	Value
Chromite	84 tons	$1,560
Manganese	247 tons	7,816
Mineral water	43,693 gals.	16,413
Quicksilver	385 flasks	24,314
Stone, miscellaneous		13,200
Other minerals		250
Total value		$63,553

LASSEN.

Area: 4,531 square miles.
Population: 8,507 (1920 census).
Location: Northeast portion of state.

Lassen County is one of the little explored sections of California. Since about 1912 a railroad traversing the county north and south has been in operation, thus affording opportunity for development along mineral and other lines.

Among the mineral resources of this county are copper, gems, gypsum, gold, silver, and sulphur. In the past, some gold has been produced, but not during the last few years, though there is prospect of resumption in 1921.

In fifty-third place, commercial production for 1920 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$7,313
Other minerals		5,000
Total value		$12,313

LOS ANGELES.

Area: 4,067 square miles.
Population: 936,438 (1920 census).
Location: One of the southwestern coast counties.

Mineral production in Los Angeles County for the year 1920 amounted in value to $26,975,163 as compared with the 1919 output, worth $23,606,381. This county ranked third in the state as a mineral producer in 1920, having passed Fresno in 1919 which was previously fourth. The advance was due to the large increase in the petroleum output and valuation.

Its output of brick and tile was over two million dollars, and that of petroleum amounted to over twenty million dollars. Among the mineral resources may be noted asphalt, barytes, borax, brick, clay, fuller's earth, gems, gold, gypsum, infusorial earth, limestone, marble, mineral paint, mineral water, natural gas, petroleum, salt, glass-sand, sandstone, serpentine, silver, soapstone, and miscellaneous stone. Some potash has been obtained from kelp.

Commercial production for 1920, consisting of 19 substances, was as follows:

Substance	Amount	Value
Brick	127,854 M.	$2,333,941
Building tile	27,954 tons	308,476
Clay	18,684 tons	91,763
Mineral water	161,466 gals.	10,371
Natural gas	6,225,835 M. cu. ft.	556,465
Petroleum	14,026,536 bbls.	21,488,653
Salt	6,502 tons	6,577
Stone, miscellaneous		1,704,951
Other minerals*		473,966
Total value		$26,975,163

*Includes borax, copper, gold, graphite, infusorial earth, lead, magnesium salts, and silver.

MADERA.

Area: 2,112 square miles.
Population: 12,203 (1920 census).
Location: East-central portion of state.

Madera County produced four mineral substances during the year 1920, having a total value of $122,925, as compared with the 1919

output, worth $117,888. The increase is due mainly to granite. This county contains deposits of copper, gold, iron, lead, molybdenum, pumice, silver, and building stone.

In forty-fifth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Copper	89,846 lbs.	$16,532
Gold		6,382
Granite		98,523
Silver		1,488
Total value		$122,925

MARIN.

Area: 529 square miles.

Population: 27,342 (1920 census).

Location: Adjoins San Francisco on the north.

Mineral production in Marin County during the year 1920 reached a value of $335,745, as compared to the 1919 output, worth $228,974, the increase being due to crushed rock, and brick. This county is not especially prolific in minerals, although among its resources along these lines are brick, gems, manganese, mineral water, soapstone, and miscellaneous stone.

In thirty-third place, commercial production for 1920 was:

Substance	Amount	Value
Stone, miscellaneous		$208,302
Other minerals*		127,443
Total value		$335,745

*Includes brick and mineral water.

MARIPOSA.

Area: 1,463 square miles.

Population: 2,775 (1920 census).

Location: Most southerly of the Mother Lode counties. East-central portion of state.

Mariposa County is one of the distinctly 'mining' counties of the state, although it stands but thirty-sixth on the list of counties in regard to the value of its mineral output for 1920, with a total of $271,031 as compared with the 1919 figure of $262,566.

Its mineral resources are varied; among the more important items being barytes, copper, gems, gold, lead, marble, silver, slate, soapstone, and miscellaneous stone.

The Yosemite Valley is in Mariposa County.

Commercial production of 1920 was as follows:

Substance	Amount	Value
Gold		$261,830
Silver		4,705
Stone, miscellaneous		400
Other minerals*		4,096
Total value		$271,031

*Includes barytes, copper, and lead.

MENDOCINO.

Area: 3,453 square miles.

Population: 24,116 (1920 census).

Location: Joins Humboldt County on the south and bounded by the Pacific Ocean on the west.

Mendocino's annual mineral production has usually been small, the 1920 output being valued at $26,110, ranking it fifty-first among the counties. That of 1919 was worth $14,214.

Deposits of, in part undetermined value of asbestos, chromite, coal, copper, graphite, magnesite, and mineral water have been found, as well as traces of gold and silver.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$7,500
Other minerals*		18,610
Total value		$26,110

*Includes chromite, manganese, natural gas, and platinum.

MERCED.

Area: 1,995 square miles.

Population: 24,579 (1920 census).

Location: About the geographical center of the state.

Merced County as a whole lies in the San Joaquin Valley, and it figures as one of the lesser mineral producing counties of the state. The 1920 mineral output was valued at $24,800. Gold, platinum, and silver were formerly obtained by dredging, but ceased in this county in 1918. Undeveloped deposits of antimony, magnesite, quicksilver, and limestone have been noted in this county in addition to the foregoing.

In fifty-second place, commercial production during 1920 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$24,800

MODOC.

Area: 3,823 square miles.

Population: 5,425 (1920 census).

Location: The extreme northwest corner of the state.

Modoc County, like Lassen, has only in recent years had the benefit of communication with the outside world by rail. Among its known mineral resources are: Clay, coal, gold, iron, quicksilver, salt, and silver.

In fifty-sixth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$700
Other minerals		3,968
Total value		$4,668

*Includes gem material, gold, salt, and silver.

MONO.

Area: 3,030 square miles.

Population: 960 (1920 census).

Location: Is bordered by the State of Nevada on the east and is about in the central portion of the state measured on a north and south line.

Gold mining has been carried on in portions of Mono County for many years, although taken as a whole it lies in a rather inaccessible country and has been but superficially explored. It is in the continuation of the highly mineralized belt which was noted in Inyo County and contains among other mineral resources barytes, clay, copper, gold, limestone, molybdenum, pumice, salt, silver, and travertine.

In thirty-ninth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Copper	3,215 lbs.	$592
Gold		144,746
Lead	85,014 lbs.	6,801
Silver		34,369
Stone, miscellaneous		1,000
Other minerals		750
Total value		$188,258

MONTEREY.

Area: 3,330 square miles.

Population: 27,980 (1920 census).

Location: West-central portion of state, bordering on Pacific Ocean.

Monterey County produced ten mineral substances during the year 1920, having a total value of $126,449, as compared with the 1919 output

worth $148,504. Its mineral resources include brick, clay, copper, coal, dolomite, feldspar, fuller's earth, gold, silver, gypsum, infusorial earth, limestone, mineral water, petroleum, quicksilver, glass-sand, sandstone, silver, and miscellaneous stone.

In forty-fourth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Dolomite	5,755 tons	$26,238
Mineral water	200 gals.	20
Stone, miscellaneous†		84,056
Other minerals*		16,135
Total value		$126,449

*Includes barytes, coal, feldspar, diatomaceous earth, salt, silica, and sand for glass making.
†Includes sand for moulding, cores, filters, and roofing.

NAPA.

Area: 783 square miles.

Population: 20,678 (1920 census).

Location: Directly north of San Francisco Bay—one of the 'bay counties.'

Napa, because of its production of structural and industrial materials and quicksilver, stands thirty-seventh on the list of mineral-producing counties in California. Its mineral resources include chromite, copper, cement, gypsum, magnesite, mineral water, quicksilver, sandstone, and miscellaneous stone.

In 1920, the value of the output decreased to $230,141 from the 1919 figure of $275,303, due mainly to quicksilver.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Mineral water	80,431 gals.	$38,621
Quicksilver	266 flasks	18,588
Stone, miscellaneous		74,556
Other minerals*		98,382
Total value		$230,141

*Includes magnesite and volcanic ash.

NEVADA.

Area: 974 square miles.

Population: 10,860 (1920 census).

Location: North of Lake Tahoe, on the eastern border of the state.

Nevada, one of the mountain counties of California, has in recent years, alternated with Amador in the gold lead, but both were passed by Yuba in 1918–1920. Nevada County stands twelfth on the list in

regard to the value of its total mineral output, with a figure of $2,955,006, as compared with the 1919 production worth $3,064,053. The decrease is due mainly to gold.

While this county actually produces mainly gold and silver, its resources cover a wide scope, including antimony, asbestos, barytes, bismuth, chromite, clay, copper, gems, iron, lead, mineral paint, pyrite, soapstone, and tungsten.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Gold		$2,872,471
Silver		58,476
Stone, miscellaneous		6,528
Other minerals*		17,531
Total value		$2,955,006

*Includes asbestos, barytes, copper, granite, and lead.

ORANGE.

Area: 795 square miles.

Population: 61,375 (1920 census).

Location: Southwestern portion of state, bordering Pacific Ocean.

Orange County is one of the many in California which on casual inspection appears to be anything but a mineral-producing section. It stands, however, as the second county in the state in regard to the total value of mineral output for 1920, its highly productive oil fields making such a condition possible.

This county, in company with most of the other oil counties, shows a gain in 1920, with a total value of mineral products of $34,108,136 from the 1919 output, worth $27,850,693. It passed Shasta County in 1917, which previously for a number of years had exceeded all other counties in California, except Kern.

Aside from the substances actually produced and noted in the table below, coal, gypsum, iron, infusorial earth, sandstone, and tourmaline have been found in Orange County.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Copper	455 lbs.	$84
Gold		145
Lead	15,932 lbs.	1,275
Natural gas	10,520,483 M. cu. ft.	862,446
Petroleum	15,462,741 bbls.	33,059,340
Silver		7,263
Stone, miscellaneous		80,988
Other minerals*		96,595
Total value		$34,108,136

*Includes brick, clay, and potash.

PLACER.

Area: 1,395 square miles.

Population: 18,584 (1920 census).

Location: Eastern border of state directly west of Lake Tahoe.

While standing only twenty-fifth on the list of mineral-producing counties, Placer contains a wide variety of mineral substances, some of which have not been commercially exploited. Its leading products are gold, chromite, granite, copper, and clay. Other mineral resources are: Asbestos, brick, coal, gems, iron, lead, limestone, magnesite, manganese, marble, quartz crystals, glass-sand, silver, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Chromite	390 tons	$7,985
Brick and tile		149,924
Clay	65,560 tons	76,500
Gold		151,088
Granite		212,625
Silver		2,178
Stone, miscellaneous		6,688
Other minerals		5,825
Total value		$612,813

PLUMAS.

Area: 2,594 square miles.

Population: 5,681 (1920 census).

Location: Northeastern border of state, south of Lassen County.

A considerable portion of the area of Plumas County lies in the high mountains, and deposits of the metals, especially gold and copper, are found there. Lack of transportation and other facilities has retarded its growth, but its future is decidedly promising. Mineral production for 1920 was valued at $2,082,662, as compared with the 1919 output, worth $2,158,196, the decrease being due mainly to copper, which placed the county fourteenth in rank. In 1919–1920 Plumas passed Shasta in the copper lead, owing to the Shasta smelters being closed down.

Among its mineral resources are: Chromite, copper, gold, granite, iron, lead, limestone, manganese, molybdenum, platinum, silver, and zinc.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Copper	9,583,834 lbs.	$1,763,425
Gold		102,097
Silver		152,373
Stone, miscellaneous		62,109
Other minerals*		2,658
Total value		$2,082,662

*Includes granite, lead, lime, and platinum.

RIVERSIDE.

Area: 7,240 square miles.
Population: 60,297 (1920 census).
Location: Southern portion of state.

Riverside is the fourth county in the state in size and the eighth in regard to the total value of mineral output for 1920. Within its borders are included mountain, desert, and agricultural land. Its mineral resources include metals, structural and industrial materials, and salines, some of the more important being borax, brick, cement, clay, coal, copper, feldspar, gems, gold, gypsum, iron, lead, limestone, manganese, magnesite, marble, mineral paint, mineral water, salt, glass-sand, soapstone, silver, miscellaneous stone, and tin. In point of variety Riverside County showed fifteen different minerals commercially produced in 1920.

The increase in 1920 over the 1919 value of $2,576,978 is due mainly to cement.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick and tile		$489,209
Clay (pottery)	76,317 tons	126,313
Feldspar	1,094 tons	6,168
Granite		26,408
Silica	3,195 tons	12,581
Stone, miscellaneous		296,499
Other minerals*		4,171,030
Total value		$5,128,208

*Includes cement, coal, gems, gypsum, mineral water, and potash.

SACRAMENTO.

Area: 983 square miles.
Population: 90,978 (1920 census).
Location: North-central portion of state.

Sacramento stands sixteenth among the counties of the state as a mineral producer, the output, principally gold, for 1920 being valued at $2,066,154, as compared with the 1919 production, worth $2,170,296. In regard to gold output alone this county ranks fourth, being exceeded only by Yuba, Amador, and Nevada counties, the product coming from the dredges. Its mineral resources include: Brick, clay, gold, natural gas, platinum, silver, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick and tile		$248,433
Gold		1,575,033
Silver		4,534
Stone, miscellaneous		180,563
Other minerals*		57,591
Total value		$2,066,154

*Includes natural gas and platinum.

SAN BENITO.

Area: 1,392 square miles.
Population: 8,995 (1920 census).
Location: West-central portion of state.

Although twentieth among the counties of the state in regard to value of total mineral production, San Benito leads in one important branch of the mineral industry, namely, quicksilver.

Its other mineral resources, many of them undeveloped, include: Antimony, bituminous rock, chromite, coal, gypsum, gems, limestone, mineral water, soapstone, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Dolomite	18,000 tons	$57,750
Quicksilver	3,887 flasks	296,942
Stone, miscellaneous		207,250
Other minerals*		921,082
Total value		$1,483,024

*Includes cement, magnesite, and mineral water.

SAN BERNARDINO.

Area: 20,157 square miles.
Population: 73,401 (1920 census).
Location: Southeastern portion of state.

San Bernardino, by far the largest county in the state, in area, ranks sixth as regards the value of its mineral output for 1920 with a total of $6,541,348, as compared with the 1919 total of $4,638,685. The increase is due to cement and silver.

San Bernardino for several years led all other counties in the state in point of variety of minerals, producing commercially during 1918, a total of 25 different substances but dropped to 17 in 1919, compared to 19 for Riverside County, and recovering first place in 1920 with 22 substances.

This county, consisting largely of mountain and desert country, is highly mineralized, the following being included among its resources: Asbestos, barytes, borax, brick, cement, clay, copper, gems, gold, granite, gypsum, iron, lead, limestone, manganese, marble, mineral paint, mineral water, nitre, potash, salt, glass-sand, soapstone, soda, miscellaneous stone, strontium, talc, tungsten, vanadium, and zinc.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Borax	5,670 tons	$440,411
Cement	1,681,283 bbls.	3,051,079
Clay	95 tons	890
Copper	5,386 lbs.	991
Gold		79,195
Lead	115,876 lbs.	9,270
Mineral water	1,110,190 gals.	156,726
Potash	15,435 tons	1,082,037
Salt	202 tons	1,220
Silver		1,212,987
Stone, miscellaneous		169,991
Other minerals*		336,551
Total value		$6,541,348

*Includes dolomite, gems, granite, gypsum, iron ore, lime, limestone, soda, and talc.

SAN DIEGO.

Area: 4,221 square miles.

Population: 112,248 (1920 census).

Location: Extreme southwest corner of state.

San Diego ranks twenty-third in the total value of its mineral output. This figure for 1920 equaled $794,229, as compared with the 1919 output worth $342,662. In 1918 for the only time in several years, there was no production of gems, in which San Diego County has lead the state. Aside from minerals commercially produced, as shown below, San Diego County contains occurrences of bismuth, lithia, marble, nickel, soapstone, and tin. Potash has been produced from kelp.

A development of recent years is the shipping of pebbles for grinding mills.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Brick and tile		$87,612
Clay	5,852 tons	57,522
Feldspar	2,953 tons	17,715
Gems		2,100
Granite		7,838
Salt	15,300 tons	77,100
Silica	7,557 tons	18,893
Stone, miscellaneous		333,847
Other minerals*		191,602
Total value		$794,229

*Includes lithia, magnesium salts, mineral water, tantalum ore (columbite).

SAN FRANCISCO.

Area: 43 square miles.

Population: 506,676 (1920 census).

Surprising as it may appear at first glance, San Francisco County is listed among the mineral producing sections of the state, actual production consisting of crushed rock, sand, and gravel. Small quantities of various valuable mineral substances are found here, including cinnabar, gypsum, lignite, and magnesite, none, however, in paying quantities.

In forty-sixth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$77,553
Other minerals		2,800
Total value		$80,353

SAN JOAQUIN.

Area: 1,448 square miles.

Population: 79,905 (1920 census).

Location: Central portion of state.

San Joaquin County reported a mineral production for the year 1920 having a total value of $471,102, as compared with the 1919 output, worth $435,618.

Comparatively few mineral substances are found here, the chief ones being brick, clay, manganese, natural gas, glass-sand, and miscellaneous stone. Gold, platinum, and silver are obtained by dredging in the Mokelumne River, which forms the boundary between this county and Amador on the northeast.

In twenty-ninth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Natural gas	200,433 M. cu. ft.	$74,957
Stone, miscellaneous		63,077
Other minerals*		333,068
Total value		$471,102

*Includes brick, gold, manganese, platinum, and silver.

SAN LUIS OBISPO.

Area: 3,334 square miles.

Population: 21,893 (1920 census).

Location: Bordered by Kern County on the east and the Pacific Ocean on the west.

The total value of the mineral production of San Luis Obispo County in 1920 was $405,604, as compared with the 1919 output, worth $212,430,

the increase being due mainly to soda. Among its mineral resources both developed and undeveloped, are: Asphalt, bituminous rock, brick, chromite, coal, copper, gypsum, infusorial earth, iron, limestone, marble, mineral water, onyx, petroleum, quicksilver, and miscellaneous stone.

In thirty-first place, commercial production for 1920 was as follows:

Substance	Amount	Value
Chromite	399 tons	$10,440
Petroleum	42,511 bbls.	59,515
Quicksilver	1,224 flasks	89,186
Other minerals*		246,463
Total value		$405,604

*Includes copper, granite, manganese, soda, and miscellaneous stone.

SAN MATEO.

Area: 447 square miles.

Population: 36,781 (1920 census).

Location: Peninsula, adjoined by San Francisco on the north.

San Mateo's most important mineral products are stone, and salt, the last-named being derived by evaporation from the waters of San Francisco Bay. The total value of all mineral production during 1920 equaled $293,103, as compared with the 1919 figures of $241,671, the increase being due to salt.

Small amounts of barytes, chromite, infusorial earth, and quicksilver have been noted in addition to the items of economic value given below. Bricks have also been produced commercially.

In thirty-fourth place, commercial production for 1920 was as follows:

Substance	Amount	Value
Petroleum	322 bbls.	$966
Salt	37,409 tons	206,897
Stone, miscellaneous		46,040
Other minerals*		39,200
Total value		$293,103

*Includes magnesium salts and potash.

SANTA BARBARA.

Area: 2,740 square miles.

Population: 41,097 (1920 census).

Location: South-western portion of state, joining San Luis Obispo on the south.

Santa Barbara County owes its position of fifth in the state in regard to its mineral output to the presence of productive oil fields within its boundaries. The total value of its mineral production during the year 1920 was $10,538,611, as compared with the 1919 output of $7,594,917.

Aside from the mineral substances listed below, Santa Barbara County contains asphalt, diatomaceous earth, gilsonite, gypsum, magnesite, and quicksilver in more or less abundance.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Mineral water	95,843 gals.	$110,931
Natural gas	1,359,665 M. cu. ft.	128,126
Petroleum	5,803,583 bbls.	9,140,643
Potash	410 tons	40,000
Stone, miscellaneous		27,436
Other minerals*		1,091,475
Total value		$10,538,611

*Includes bituminous rock, brick, diatomaceous earth, quicksilver, and sandstone.

SANTA CLARA.

Area: 1,328 square miles.

Population: 100,588 (1920 census).

Location: West-central portion of state.

Santa Clara County reported a mineral output for 1920 of $1,038,692 as compared with the 1919 figures of $1,048,571.

This county, lying largely in the Coast Range Mountains, contains a wide variety of mineral substances, including brick, chromite, clay, limestone, magnesite, manganese, mineral water, petroleum, quicksilver, soapstone, and miscellaneous stone. It stood second in quicksilver yield for the year.

In twenty-second place, commercial production for 1920 was as follows:

Substance	Amount	Value
Brick	11,890 M.	$164,680
Clay	1,900 tons	4,600
Magnesite	26,612 tons	392,580
Mineral water	3,360 gals.	480
Petroleum	16,095 bbls.	23,901
Quicksilver	2,893 flasks	233,199
Stone, miscellaneous		129,582
Other minerals*		89,670
Total value		$1,038,692

*Includes limestone and potash.

SANTA CRUZ.

Area: 435 square miles.

Population: 26,269 (1920 census).

Location: Bordering Pacific Ocean, just south of San Mateo County.

The mineral output of Santa Cruz County, a portion of which is itemized below, amounted to a total value of $3,081,138, giving the

county a standing of eleventh among all others in the state in this regard.

The increase over the 1919 figure of $2,245,056 is due mainly to cement.

The commercial production for 1920 was as follows:

Substance	Amount	Value
Lime	141,633 bbls.	$202,908
Limestone	5,062 tons	20,101
Stone, miscellaneous		23,379
Other minerals*		2,834,750
Total value		$3,081,138

*Includes bituminous rock, cement, iron ore, mineral paint, and potash.

SHASTA.

Area: 3,858 square miles.
Population: 13,311 (1920 census).
Location: North-central portion of state.

Shasta County stood twenty-first in California among the mineral producing counties for 1920, with an output valued at $1,108,538, as compared with the 1919 production worth $2,776,803. The marked decrease in 1918–1920 was due to the falling off in the output of copper, the large plants of the Mammoth and Mountain copper companies being shut down. Not taking petroleum into account, Shasta for a number of years led all of the counties by a wide margin; but in 1919–1920 was passed by San Bernardino, Inyo, Yuba, Plumas, Amador, Calaveras, and Nevada among the 'metal' counties.

Shasta's mineral resources include: Asbestos, barytes, brick, chromite, coal, copper, gold, iron, lead, lime, limestone, mineral water, molybdenum, pyrite, silver, soapstone, miscellaneous stone, and zinc.

Lassen Peak is located in southeastern Shasta County.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Copper	810,843 lbs.	$149,195
Gold		312,901
Lead	64,400 lbs.	5,152
Platinum	158 fine oz.	27,004
Pyrites	135,399 tons	475,330
Silver		36,563
Stone, miscellaneous		32,650
Other minerals*		69,743
Total value		$1,108,538

*Includes asbestos, brick, iron ore, lime, limestone, and zinc.

SIERRA.

Area: 923 square miles.

Population: 1,783 (1920 census).

Location: Eastern border of state, just north of Nevada County.

Sierra County reported a mineral production of $446,861, consisting of gold and silver, during the year 1920, as compared with the 1919 output, worth $304,879. Considering gold output alone, this county stands eighth; and as to total mineral yield thirtieth.

Aside from the metals itemized below, Sierra County contains deposits of asbestos, chromite, copper, iron, lead, platinum, minerals, serpentine, and talc.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Gold		$442,894
Silver		3,967
Total value		$446,861

SISKIYOU.

Area: 6,256 square miles.

Population: 18,545 (1920 census).

Location: Extreme north-central portion of state, next to Oregon boundary.

Siskiyou, fifth county in California in regard to size, located in a highly mineralized and mountainous country, ranks thirty-eighth in regard to the value of its mineral output for 1920. The decrease in 1920 was due mainly to gold.

Although the county is traversed by a transcontinental railroad in a north and south line, the mineral-bearing sections are almost without exeeption far from transportation and other facilities. A large part of the county is accessible by trail alone. Future development and exploitation will doubtless increase the productiveness of this part of the state to a great degree.

Mount Shasta is located in Siskiyou County.

Among Siskiyou's mineral resources are: Chromite, clay, coal, copper, gems, gold, lead, limestone, manganese, marble, mineral water, pumice, quicksilver, sandstone, silver, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Chromite	215 tons	$5,732
Gold		80,707
Mineral water	300,150 gals.	60,015
Silver		5,218
Stone, miscellaneous		30,322
Other minerals*		47,121
Total value		$229,115

*Includes copper, lime, limestone, potash, pumice, and quicksilver.

SOLANO.

Area: 822 square miles.
Population: 40,602 (1920 census).
Location: Touching San Francisco Bay on the northeast.

Solano, while mostly valley land, produced mineral substances during the year 1920 to the total value of $2,930,614, ranking thirteenth among the counties of the state, the increase over 1919 being due to cement. Among her mineral resources are: Brick, cement, clay, fuller's earth, limestone, mineral water, natural gas, onyx, petroleum, quicksilver, salt, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Unapportioned*		$2,930,614

*Includes cement, limestone, onyx, mineral water, natural gas, quicksilver, and miscellaneous stone.

SONOMA.

Area: 1,577 square miles.
Population: 51,990 (1920 census).
Location: South of Mendocino County, bordering on the Pacific Ocean.

Sonoma ranked thirty-fifth among the counties of California during the year 1920, with a mineral production of $287,245, as compared with its 1919 output worth $286,038. More paving blocks have been turned out here than in any other section of the state.

Among Sonoma's mineral resources are: Brick, chromite, clay, copper, graphite, infusorial earth, magnesite, manganese, marble, mineral paint, mineral water, quicksilver, and miscellaneous stone.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Mineral water	29,928 gals.	$6,578
Stone, miscellaneous		217,667
Other minerals*		63,000
Total value		$287,245

*Includes magnesite and quicksilver.

STANISLAUS.

Area: 1,450 square miles.
Population: 43,557 (1920 census).
Location: Center of state, bounded on south by Merced County.

Gold has usually been the chief mineral product of Stanislaus County, but it was exceeded in 1918–1919 by manganese. Brick, clay, gypsum,

iron, mineral paint, quicksilver, and silver are found here to some extent as well. This county for 1920 ranks thirty-second in the state in regard to value of minerals, with an output of $385,017 as compared with $544,725 in 1919, the decrease being due mainly to manganese. Gold, platinum, and silver are obtained mainly by dredging.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Gold		$142,467
Magnesite	4,064 tons	39,435
Manganese	893 tons	12,973
Mineral paint	669 tons	7,062
Silver		775
Stone, miscellaneous		181,262
Other minerals*		1,043
Total value		$385,017

*Includes platinum and quicksilver.

SUTTER.

Area: 608 square miles.

Population: 10,115 (1920 census).

Location: Bounded by Butte County on the north and Sacramento on the south.

Sutter is one of only two counties in the state which for a number of years reported no commercial output of some kind of mineral substance. In 1917 some crushed rock was taken out, from the Marysville Buttes, but there was no production in 1918, nor 1919. The 1920 mineral yield was valued at $54, being concealed under 'unapportioned.' Both coal and clay exist here, but deposits of neither mineral have been placed on a productive basis.

TEHAMA.

Area: 2,893 square miles.

Population: 12,882 (1920 census).

Location: North-central portion of the state, bounded on the north by Shasta.

Tehama stands fiftieth among the fifty-six mineral producing counties of the state for 1920, when its output was valued at $26,400, as compared with the 1919 yield worth $9,000. The advance in 1918 and the drop in 1919 was due to chromite.

Among its mineral resources are listed: Brick, chromite, copper, gold, manganese, marble, mineral water, salt, and miscellaneous stone.

Substance	Amount	Value
Unapportioned		$26,400

TRINITY.

Area: 3,166 square miles.
Population: 2,551 (1920 census).
Location: Northwestern portion of state.

Trinity, like Siskiyou County, requires transportation facilities to further the development of its many and varied mineral resources. Deposits of asbestos, barytes, chromite, copper, gold, mineral water, platinum, quicksilver, silver, and building stone are known here, but with the exception of gold, chromite, copper, and platinum, very little active production of these mineral substances has been made as yet. The 1920 output of $562,105 shows a decrease from the 1919 figure of $571,649.

In the twenty-seventh place, commercial output for 1920 was:

Substance	Amount	Value
Gold		$541,387
Platinum	37 fine oz.	6,612
Silver		3,469
Stone, miscellaneous		8,799
Other minerals		1,838
Total value		$562,105

TULARE.

Area: 4,856 square miles.
Population: 59,031 (1920 census).
Location: Bounded by Inyo on the east, Kern on the south, Fresno on the north.

Tulare stands twenty-sixth on the list of mineral-producing counties, the increase over the 1919 value being due to magnesite. This county's mineral resources, among others, are: Brick, clay, copper, feldspar, graphite, gems, limestone, magnesite, marble, quartz, glass-sand, soapstone, miscellaneous stone, and zinc. Tulare for a number of years has led the state in magnesite output, except in 1918, when it was passed by Napa County.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Magnesite	35,305 tons	$394,169
Natural gas	400 M. cu. ft.	195
Stone, miscellaneous		8,465
Other minerals*		190,467
Total value		$593,296

*Includes brick, feldspar, granite, and limestone.

TUOLUMNE.

Area: 2,190 square miles.
Population: 7,768 (1920 census).
Location: East-central portion of state—Mother Lode District.

Tuolumne ranks twenty-eighth among counties of the state relative to its total value of mineral output. As a producer of marble its standing is first. The decrease in 1920 to $513,914 from the 1919 figure of $674,493 was due to gold.

Chromite, clay, copper, gold, lead, limestone, marble, mineral paint, platinum, soapstone, silver, and miscellaneous stone are among its mineral resources.

Commercial production for 1920 was as follows:

Substance	Amount	Value
Gold		$254,569
Limestone	7,494 tons	15,288
Silver		6,007
Stone, miscellaneous		28,696
Other minerals*		209,354
Total value		$513,914

*Includes dolomite, lime, marble, and platinum.

VENTURA.

Area: 1,878 square miles.
Population: 28,724 (1920 census).
Location: Southwestern portion of state, bordering on Pacific Ocean.

Ventura is the seventh county in the state in respect to the value of its mineral production for 1920, the exact figure being $5,229,175, as compared with the output for 1919, worth $3,017,074, the advance being due to petroleum.

The highest gravity petroleum produced in the state is found here.

Among its other mineral resources are: Asphalt, borax, brick, clay, mineral water, natural gas, sandstone, and miscellaneous stone.

The commercial production for 1920 was as follows:

Substance	Amount	Value
Natural gas	1,521,448 M. cu. ft.	$214,280
Petroleum	1,989,681 bbls.	4,988,130
Stone, miscellaneous		26,265
Other minerals*		500
Total value		$5,229,175

*Includes mineral paint and sandstone.

YOLO.

Area: 1,014 square miles.
Population: 17,105 (1920 census).
Location: Sacramento Valley, bounded by Sutter on the east and Colusa on the north.

The mineral production from Yolo County during the year 1920 consisted mainly of miscellaneous stone, valued at $9,472, ranking it in fifty-fifth place. Deposits of undetermined value of iron and sandstone have been discovered within the confines of this county. Quicksilver has also been produced.

YUBA.

Area: 639 square miles.
Population: 10,375 (1920 census).
Location: Lies west of Sierra and Nevada counties; south of Plumas.

Yuba is tenth of the fifty-six mineral producing counties of the state, and leads in regard to gold output, surpassing both Nevada and Amador counties in 1918–1920 in that metal. Iron and clay deposits have been reported in this county, aside from the following commercial production shown for the year 1920, the decrease from the 1919 figure of $4,261,545 being due to gold.

Substance	Amount	Value
Gold		$3,467,769
Platinum	113 fine oz.	14,395
Silver		16,502
Stone, miscellaneous		74,943
Other minerals		40
Total value		$3,573,649

CHAPTER EIGHT.

APPENDIX.

MINING BUREAU ACT.

Chapter 679.

[Stats., 1913.]

An act establishing a state mining bureau, creating the office of state mineralogist, fixing his salary and prescribing his powers and duties; providing for the employment of officers and employees of said bureau, making it the duty of persons in charge of mines, mining operations and quarries to make certain reports, providing for the investigation of mining operations, dealings and transactions and the prosecution for defrauding, swindling and cheating therein, creating a state mining bureau fund for the purpose of carrying out the provisions of this act and repealing an act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all acts amendatory thereof and supplemental thereto or in conflict herewith.

[Approved June 16, 1913. In effect August 10, 1913.]

The people of the State of California do enact as follows:

SECTION 1. There is hereby created and established a state mining bureau. The chief officer of such bureau shall be the state mineralogist, which office is hereby created.

SEC. 2. It shall be the duty of the governor of the State of California and he is hereby empowered to appoint a citizen and resident of this state, having a practical and scientific knowledge of mining, to the office of state mineralogist. Said state mineralogist shall hold his office at the pleasure of the governor. He shall be a civil executive officer. He shall take and subscribe the same oath of office as other state officers. He shall receive for his services a salary of three hundred dollars ($300) per month, to be paid at the same time and in the same manner as the salaries of other state officers. He shall also receive his necessary traveling expenses when traveling on the business of his office. He shall give bond for the faithful performance of his duties in the sum of ten thousand dollars ($10,000), said bond to be approved by the governor of the State of California.

SEC. 3. Said state mineralogist shall employ competent geologists, field assistants, qualified specialists and office employees when necessary in the execution of his plans and operations of the bureau, and fix their compensation. The said employees shall be allowed their necessary traveling expenses when traveling on the business of said department and shall hold office at the pleasure of said state mineralogist.

SEC. 4. It shall be the duty of said state mineralogist to make, facilitate, and encourage, special studies of the mineral resources and mineral industries of the state. It shall be his duty: to collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use; to make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the state mining bureau; to provide a library of books, reports, drawings, bearing upon the mineral industries, and sciences of mineralogy and geology, and arts of mining and metallurgy, such library constituting the library of the state mining bureau; to make a collection of models, drawings and descriptions of the mechanical appliances used in mining and metallurgical processes; to preserve and so maintain such collections and library

as to make them available for reference and examination, and open to public inspection at reasonable hours; to maintain, in effect, a bureau of information concerning the mineral industries of this state, to consist of such collections and library, and to arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it; to issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this state.

SEC. 5. It is hereby made the duty of the owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character, within the state, to forward to the state mineralogist, upon his request, at his office not later than the thirtieth day of June, in each year, a detailed report upon forms which will be furnished showing the character of the mine, the number of men then employed, the method of working such mine and the general condition thereof, the total mineral production for the past year, and such owner, lessor, lessee, agent, manager or other person in charge of any mine within the state must furnish whatever information relative to such mine as the state mineralogist may from time to time require for the proper discharge of his official duties. Any owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character within the state, who fails to comply with the above provisions shall be deemed guilty of a misdemeanor.*

SEC. 6. The state mineralogist now performing the duties of the office of state mineralogist shall perform the duties of the office of state mineralogist as in this act provided until the appointment and qualification of his successor as in this act provided.

SEC. 7. The said state mineralogist shall take possession, charge and control of the offices now occupied and used by the board of trustees and state mineralogist and the museum, library and laboratory of the mining bureau located in San Francisco as provided for by a certain act of the legislature approved March 23, 1893, and hereafter referred to in section fourteen hereof, and shall maintain such offices, museum, library and laboratory for the purposes provided in this act.

SEC. 8. Said state mineralogist or qualified assistant shall have full power and authority at any time to enter or examine any and all mines, quarries, wells, mills, reduction works, refining works and other mineral properties or working plants in this state in order to gather data to comply with the provisions of this act.

SEC. 9. The state mineralogist shall make a biennial report to the governor on or before the fifteenth day of September next preceding the regular session of the legislature.

SEC. 10. All moneys received by the state mining bureau or any officer thereof (except such as may be paid to them by the state for disbursement) shall be receipted for by the state mineralogist or other officer authorized by him to act in his place and at least once a month accounted for by him to the state controller and paid into the state treasury to the credit of a fund which is hereby created and designated "state mining bureau fund." All moneys now in the possession of the state mining bureau or any officer thereof received from any source whatsoever, shall be immediately paid over to the state mineralogist and by him accounted for to the controller and paid into the state treasury to the credit of said fund. Said fund shall be used and is hereby appropriated for the use of said bureau in carrying out the purposes of this act.

SEC. 11. The said state mineralogist is hereby authorized and empowered to receive on behalf of this state, for the use and benefit of the state mining bureau, gifts, bequests, devises and legacies of real or other property and to use the same in accordance with the wishes of the donors, and if no instructions are given by said donors, to manage, use, and dispose of the gifts and bequests and legacies for the best interests of said state mining bureau and in such manner as he may deem proper.

*Sec. 19 of the Penal Code of California provides: "Except in cases where a different punishment is prescribed by this code, every offense declared to be a misdemeanor is punishable by imprisonment in a county jail not exceeding six months, or by a fine not exceeding five hundred dollars, or by both."

SEC. 12. The state mineralogist may, whenever he deems it advisable, prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the state.

SEC. 13. The state mineralogist is hereby empowered to fix a price upon and to dispose of to the public, at such price, any and all publications of the state mining bureau, including reports, bulletins, maps, registers or other publications, such price shall approximate the cost of publication and distribution. Any and all sums derived from such disposition, or from gifts or bequests made, as hereinbefore provided must be accounted for by said state mineralogist and turned over to the state treasurer to be credited to the mining bureau fund as provided for in section ten. He is also empowered to furnish without cost to public libraries the publications of the bureau, and to exchange publications with other geological surveys and scientific societies, etc.

SEC. 14. The state mineralogist provided for by this act shall be the successor in interest of the board of trustees of the state mining bureau, and the state mineralogist, under and by virtue of that certain act, entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management, and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all books, papers, documents, personal property, records, and property of every kind and description obtained or possessed, or held or controlled by the said board of trustees of the said state mining bureau, and the state mineralogist, and the clerks and employees thereof, under the provisions of said act of March 23, 1893, or any act supplemental thereto or amendatory thereof, shall immediately be turned over and delivered to the said state mineralogist herein provided for, who shall have charge and control thereof.

SEC. 15. That certain act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, and to provide for the appointment, duties and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction, and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, together with all acts amendatory thereof and supplemental thereto and all acts in conflict herewith are hereby repealed.

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*Sierra County	----
*Siskiyou County	----
*Trinity County	----
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*Desert Region of Southern California	.10
Minaret Region, Madera County	.20
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Tuolumne County	.25
Geological Map of California (50x60 in.)—mounted	2.50
Geological Map of Inyo County	.60

OIL FIELDS MAPS.

The following maps of the oil fields of the state have been completed and placed on sale.

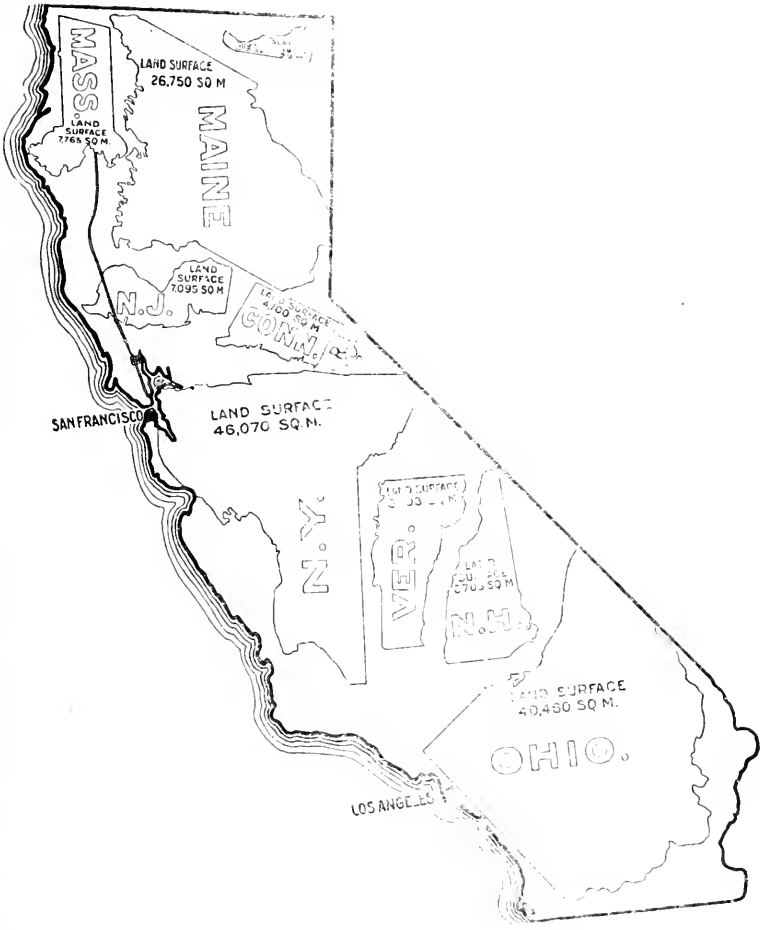
The prices of the maps are 75 cents per copy, with the exception of the Sargent oil map, which is 50 cents. These prices include postage.

Map No. 1—Sargent, Santa Clara County.
Map No. 2—Santa Maria, including Cat Cañon and Los Alamos.
Map No. 3—Santa Maria, including Casmalia and Lompoc.
Map No. 4—Whittier-Fullerton, including Olinda, Brea Cañon, Puente Hills, East Coyote, and Richfield.
Map No. 5—Whittier-Fullerton, including Whittier, West Coyote, and Montebello.
Map No. 6—Salt Lake, Los Angeles County.
Map No. 7—Sunset and San Emidio, Kern County.
Map No. 8—South Midway and Buena Vista Hills, Kern County.
Map No. 9—North Midway and McKittrick, Kern County.

Map No. 10—Belridge and McKittrick Front, Kern County.
Map No. 11—Lost Hills and North Belridge, Kern County.
Map No. 12—Devils Den, Kern County.
Map No. 13—Kern River, Kern County.
Map No. 14—Coalinga, Fresno County.
Map No. 15—Elk Hills, Kern County.
Map No. 16—Ventura-Ojai, Ventura County.
Map No. 17—Santa Paula-Sespe Oil Fields, Ventura County.
Map No. 18—Piru-Simi-Newhall.
Map No. 19—Arroyo Grande, San Luis Obispo County.
Map No. 20—Huntington Beach-Newport.
Map No. 21—Portion of District 4, showing boundaries of oil fields, Kern and Kings Counties.
Map No. 22—Portion of District 3, showing oil fields, Santa Barbara County.
Map No. 23—Portion of District 2, showing boundaries of oil fields, Ventura County.
Map No. 24—Portion of District 1, showing boundaries of oil fields, Los Angeles and Orange Counties.
Map No. 25—Kern River Oil Field.
Map No. 26—Huntington Beach, Orange County.

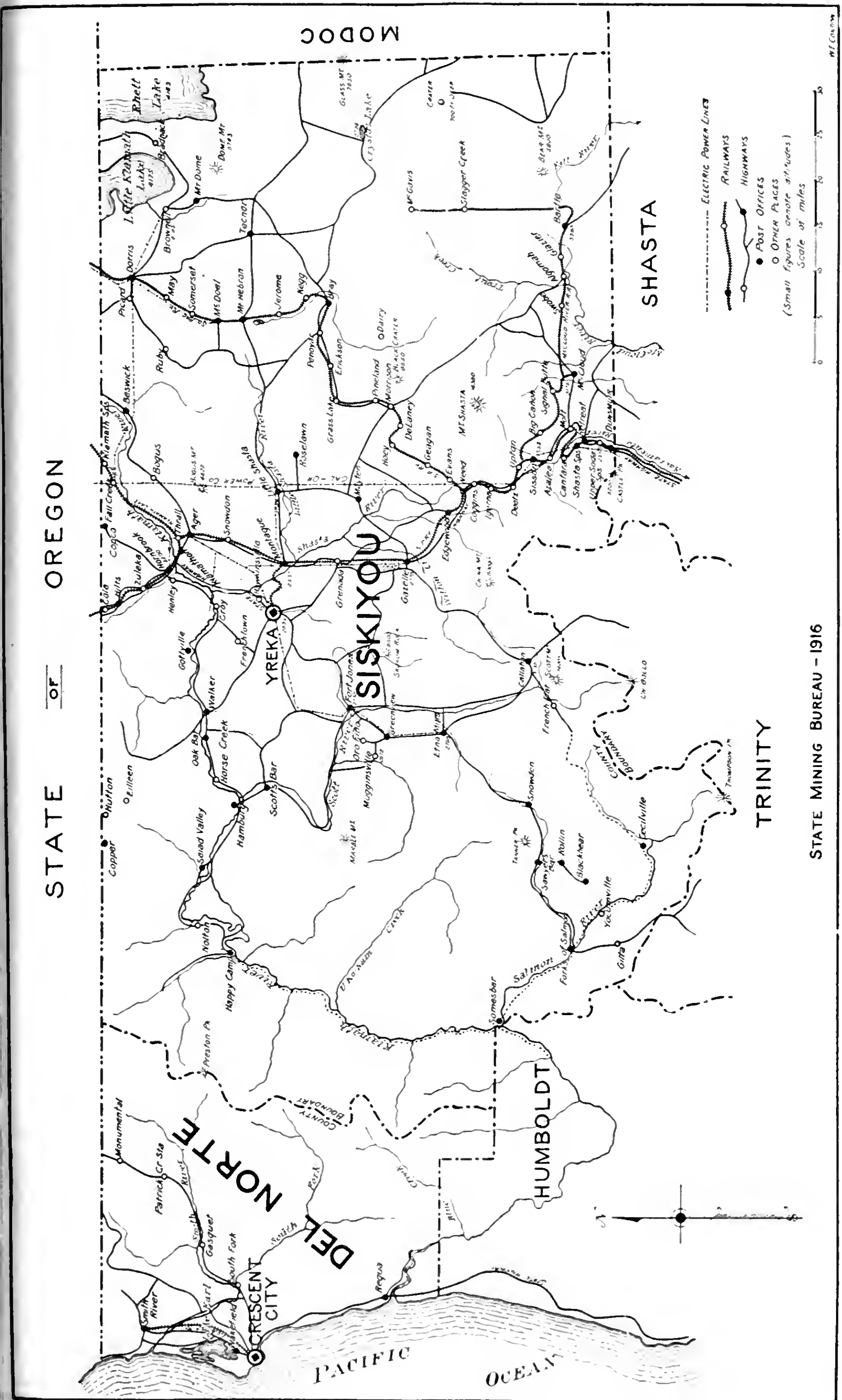
DETERMINATION OF MINERAL SAMPLES.

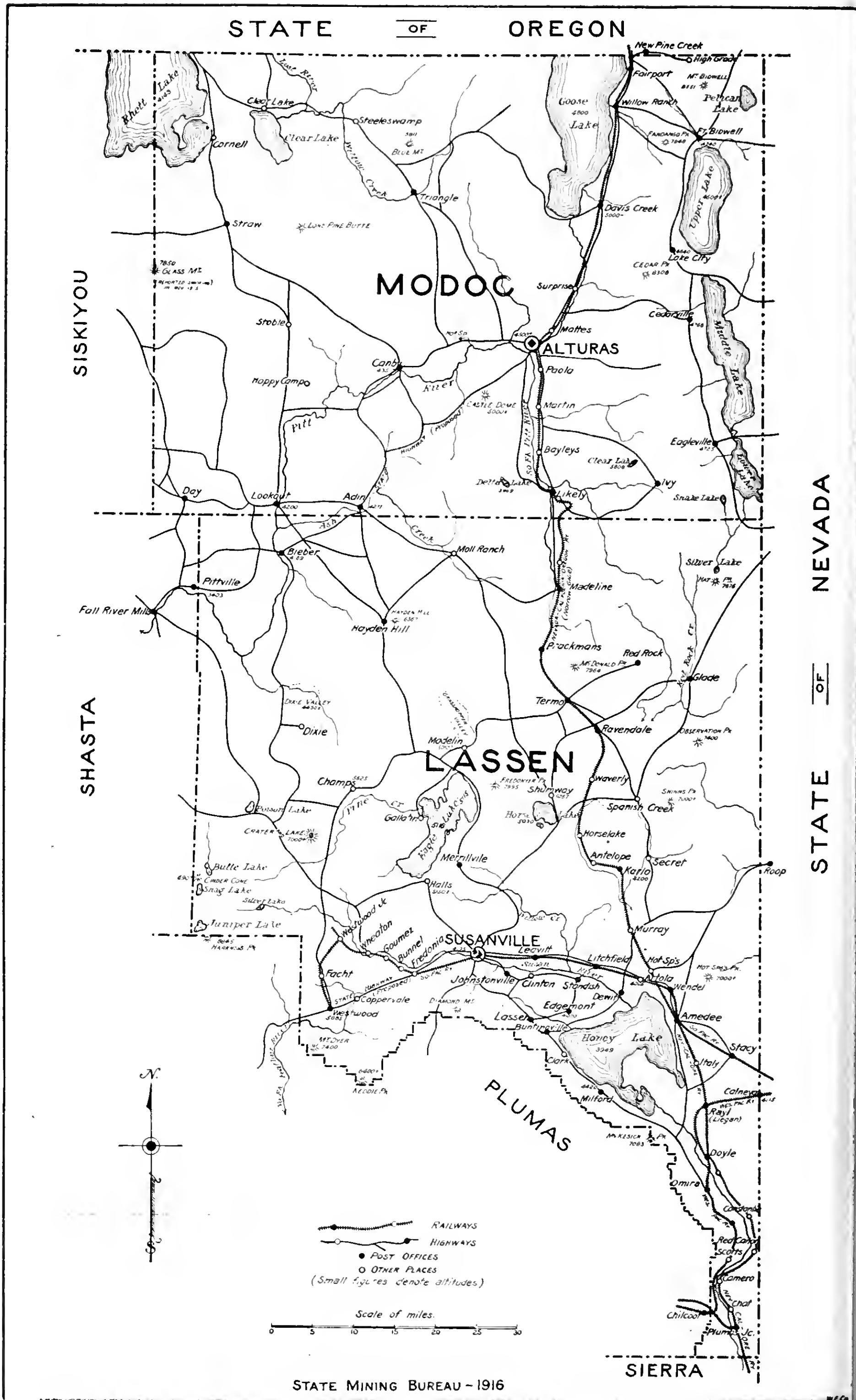
Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.



Outline map of California, showing relative areas of ten other states.

The following county maps show all towns, post offices, railroads, stage lines, and the highways. They are especially valuable to all who wish to leave the railroad and penetrate to the interior of the mining districts of the state. These maps must not be reproduced without obtaining permission from the Mining Bureau.


STATE OF OREGON
MODOC
SHASTA
SISKIYOU
TRINITY
HUMBOLDT
DEL NORTE
YREKA
CRESCENT CITY
PACIFIC OCEAN
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU - 1916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SISKIYOU
SHASTA
STATE OF NEVADA
PLUMAS
SIERRA
MODOC
LASSEN
ALTURAS
SUSANVILLE
New Pine Creek
High Grade
Fairport
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Straw
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Pit River
Castle Dome
So. Fk. Pit River
Day
Lookout
Adin
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Bieber
Moll Ranch
Pittville
Fall River Mills
Hayden Hill
Madeline
Silver Lake
Hat Pk.
Prackmans
Red Rock
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Glade
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Termo
Ravendale
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Dixie Valley
Dixie
Madelin
Champs
Pine Cr.
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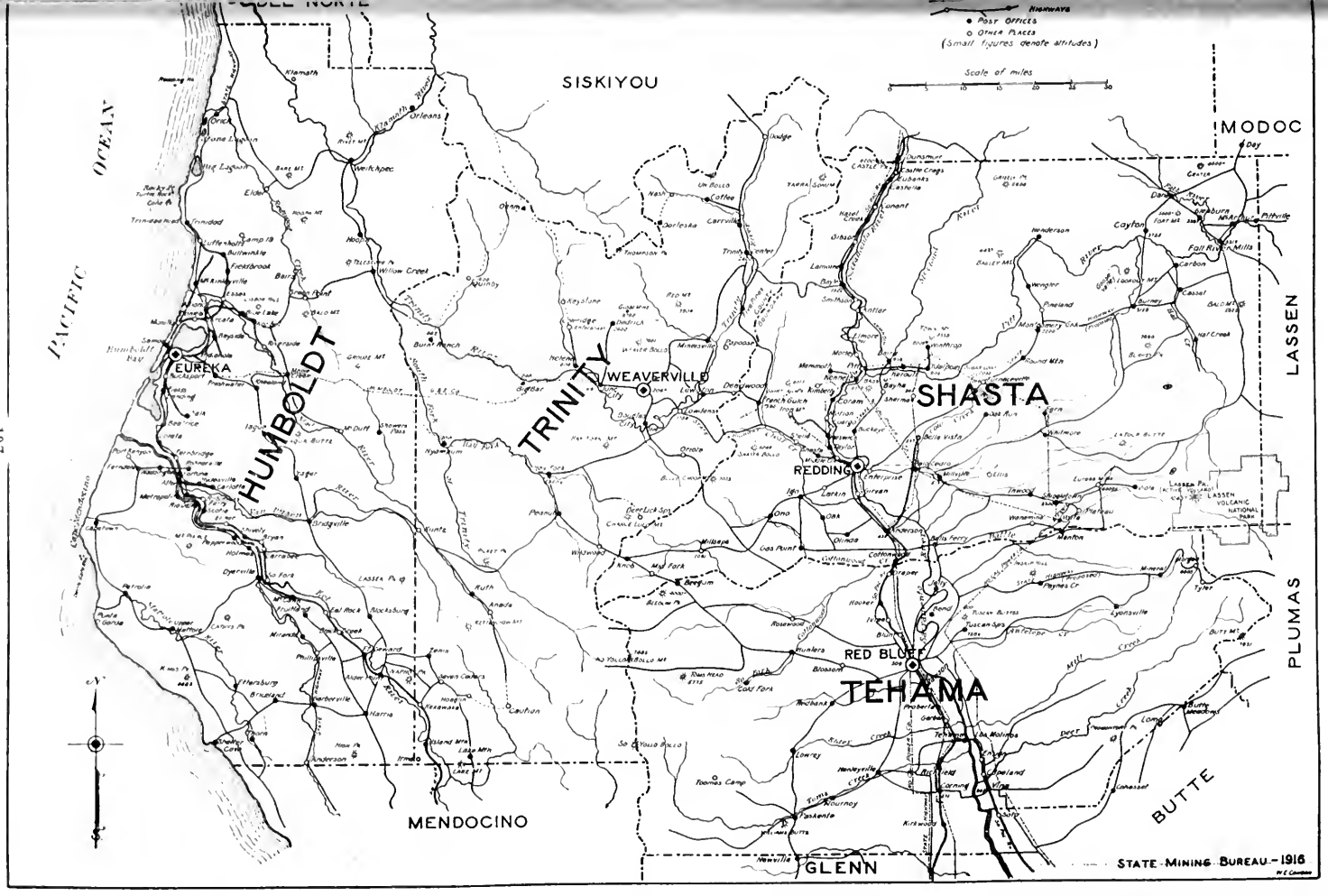
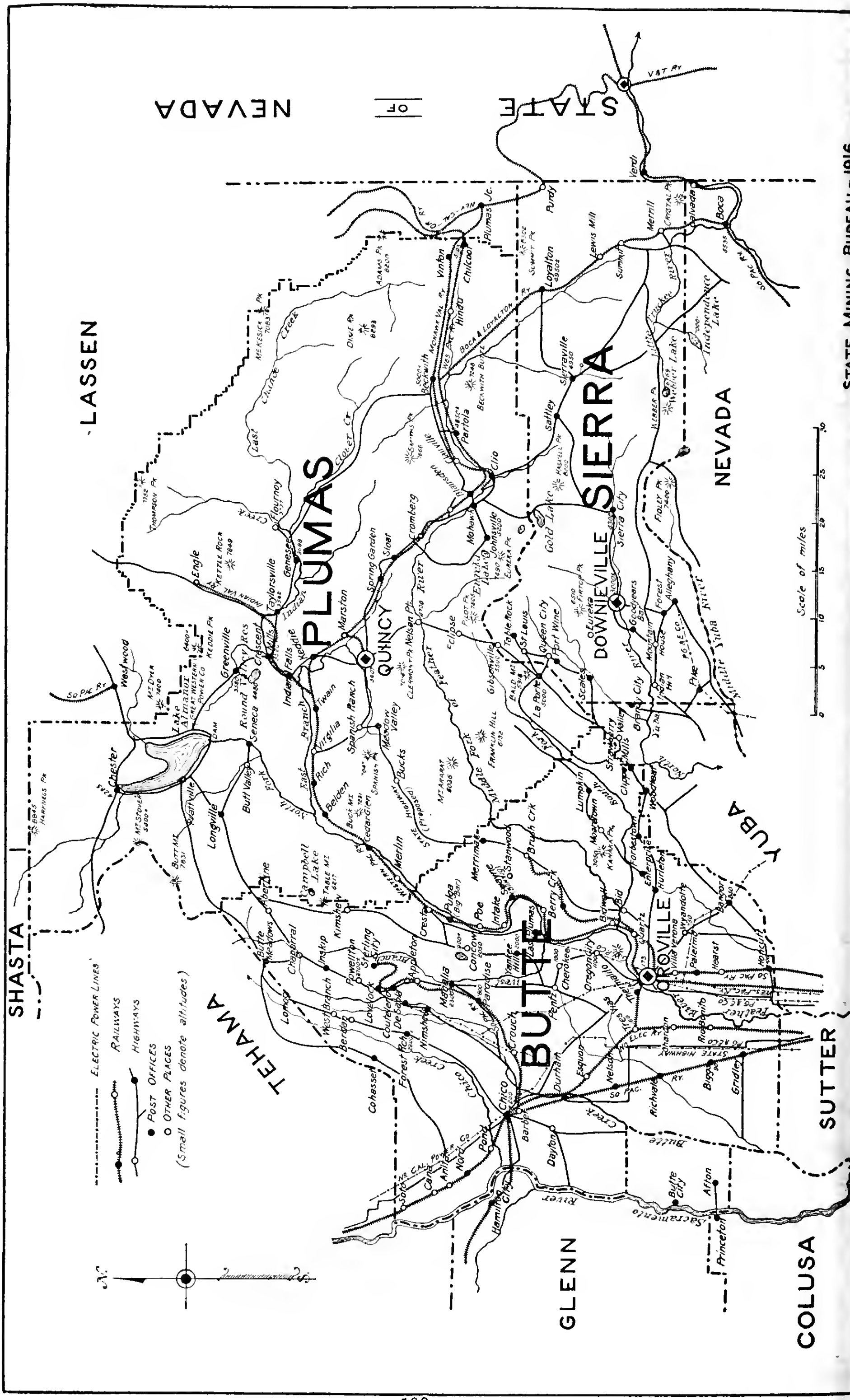
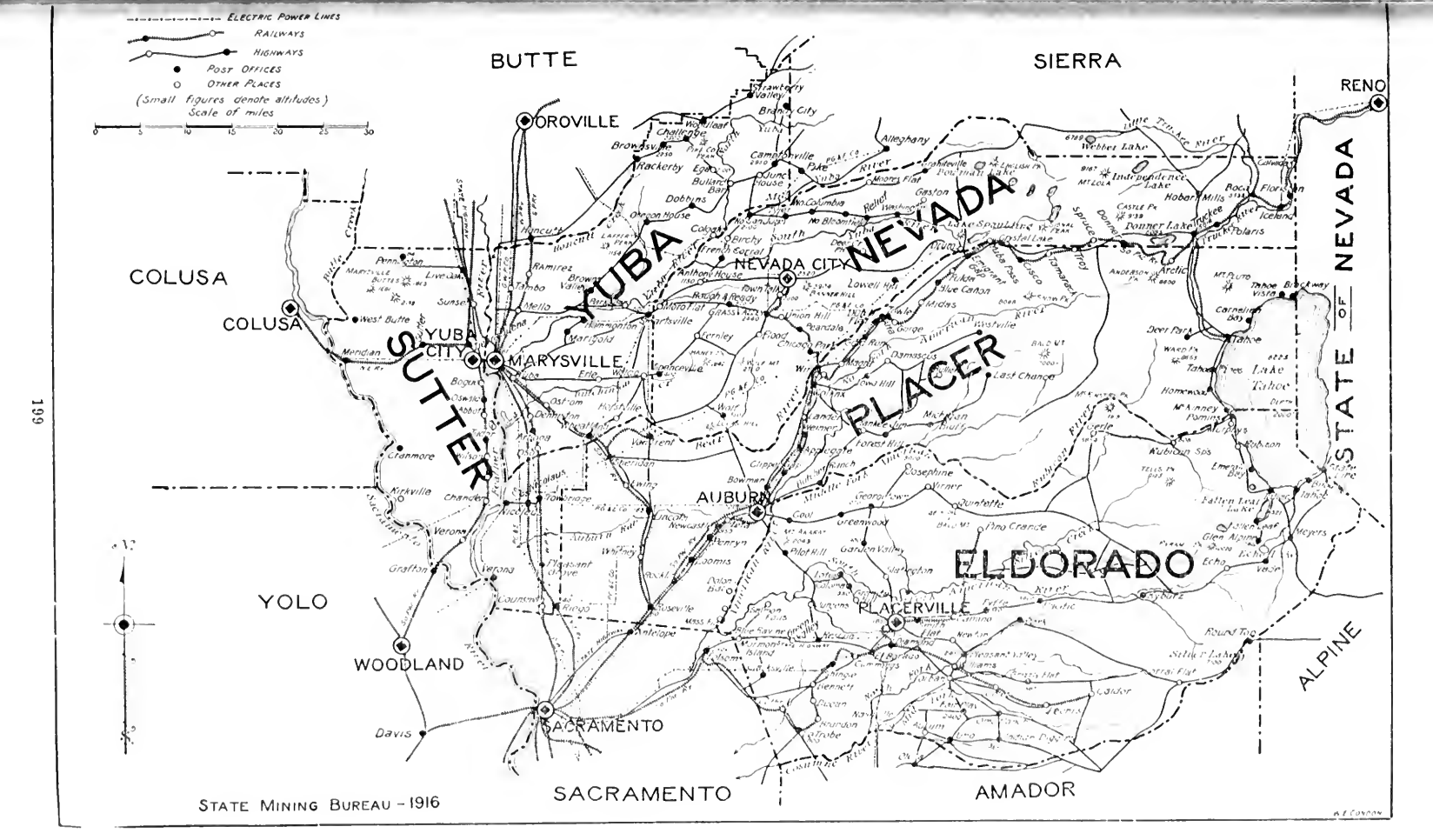
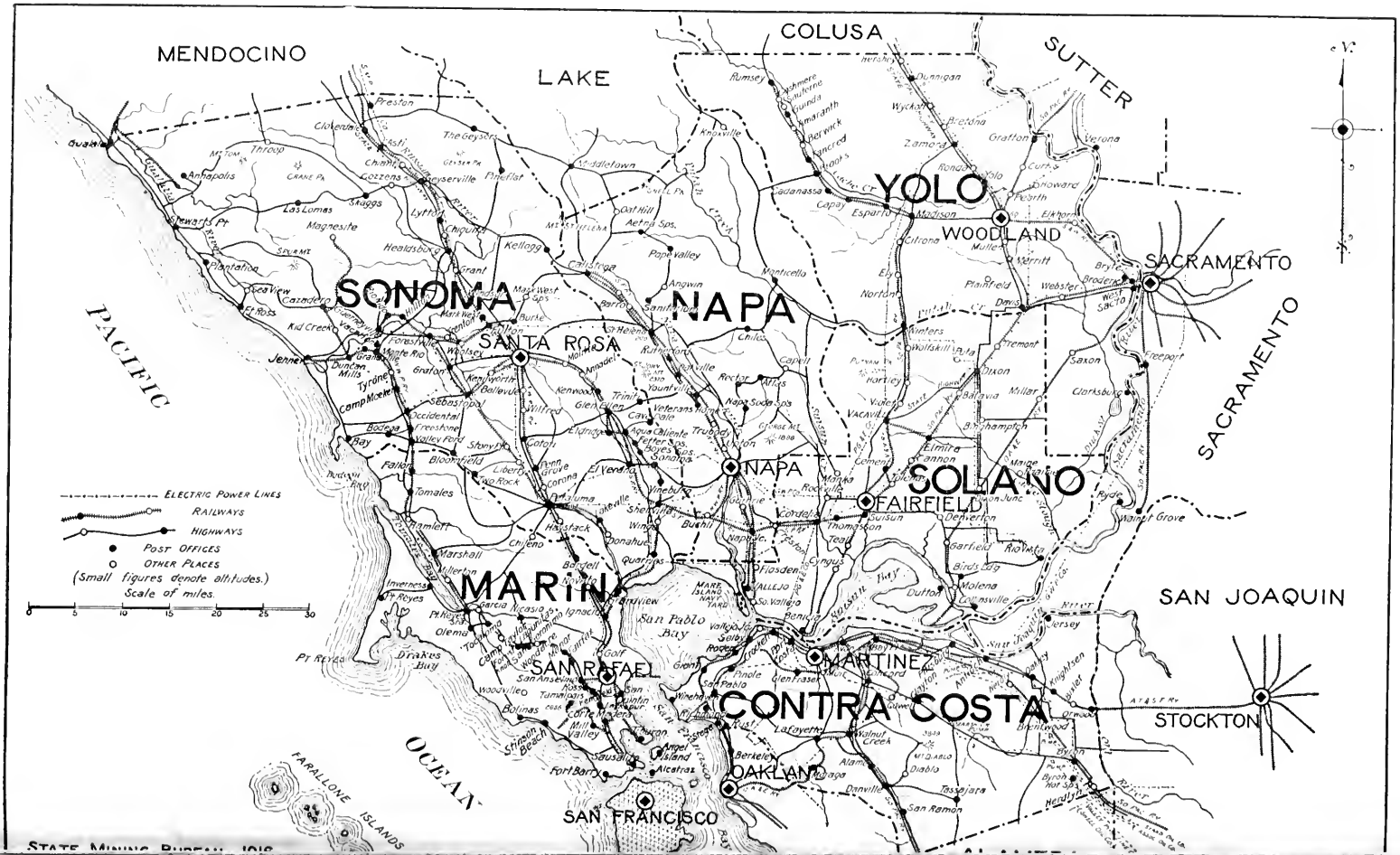
Snag Lake
Silver Lake
Juniper Lake
Harkness Pk.
Westwood Jk.
Wheaton
Goumez
Bunnel
Fredonia
Willow Cr.
Murray
Leavitt
Litchfield
Hot Sp's
Hot Spgs. Pk.
Facht
Johnstonville
Clinton
Standish
Susan River
Artola
Wendel
Dewitt
Coppervale
Westwood
Diamond Mt.
Edgemont
Amedee
Lassen
Buntingville
Honey Lake
Stacy
Mt. Dyer
Clark
Italy
Keddie Pk.
Milford
Calneva
Rayl (Liegan)
McKesick Pk.
Doyle
Omira
Constantia
Red Cañon
Scotts
Hamero
Chat
Chilcoot
Plumas Jc.
N.
Railways
Highways
Post Offices
Other Places
(Small figures denote altitudes)
Scale of miles
0
5
10
15
20
25
30
State Mining Bureau - 1916


Post Offices
Other Places
(Small figures denote altitudes)
Scale of miles
SISKIYOU
MODOC
LASSEN
PLUMAS
BUTTE
TEHAMA
GLENN
MENDOCINO
HUMBOLDT
TRINITY
SHASTA
EUREKA
WEAVERVILLE
REDDING
RED BLUFF
PACIFIC OCEAN
STATE MINING BUREAU - 1916

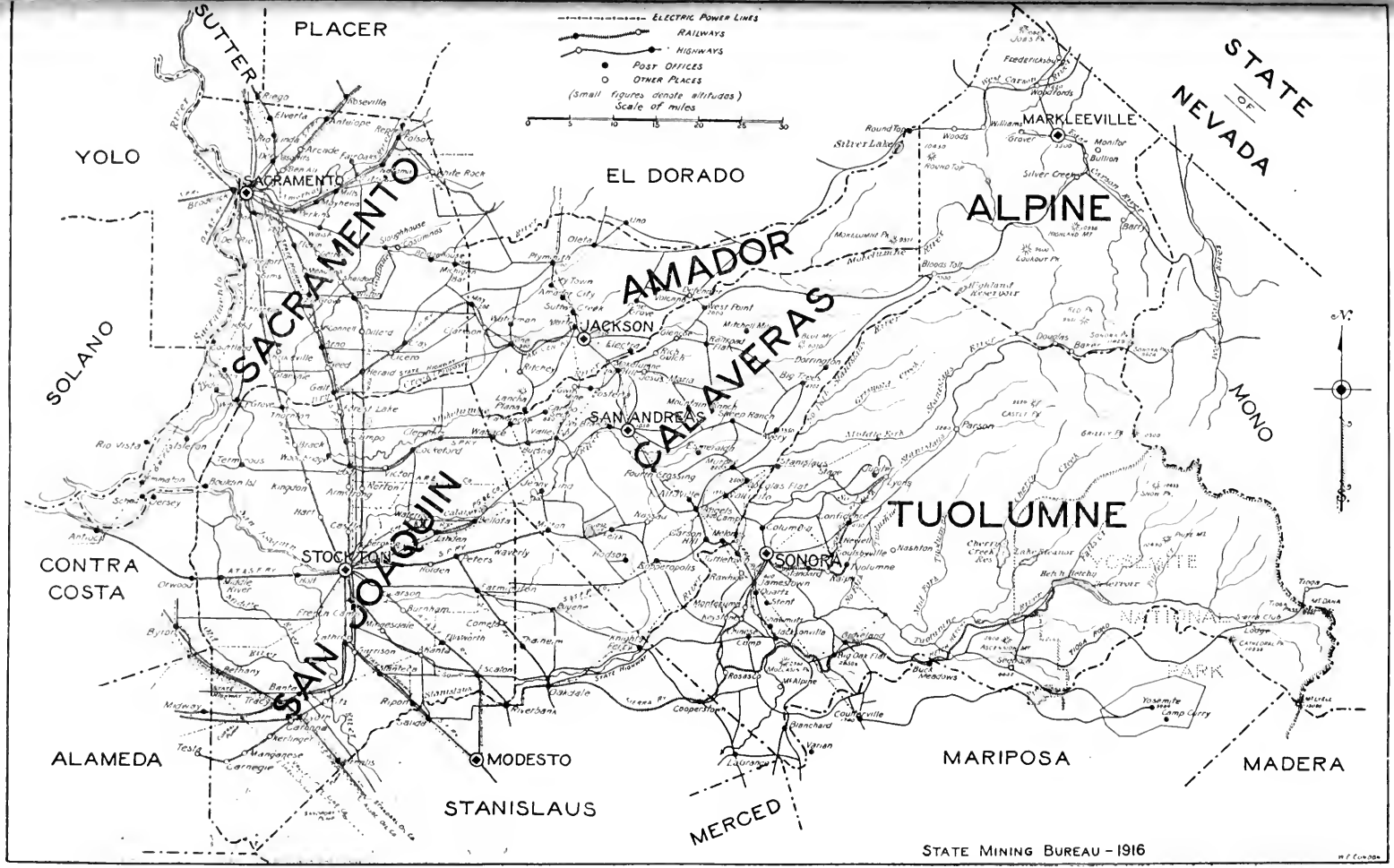


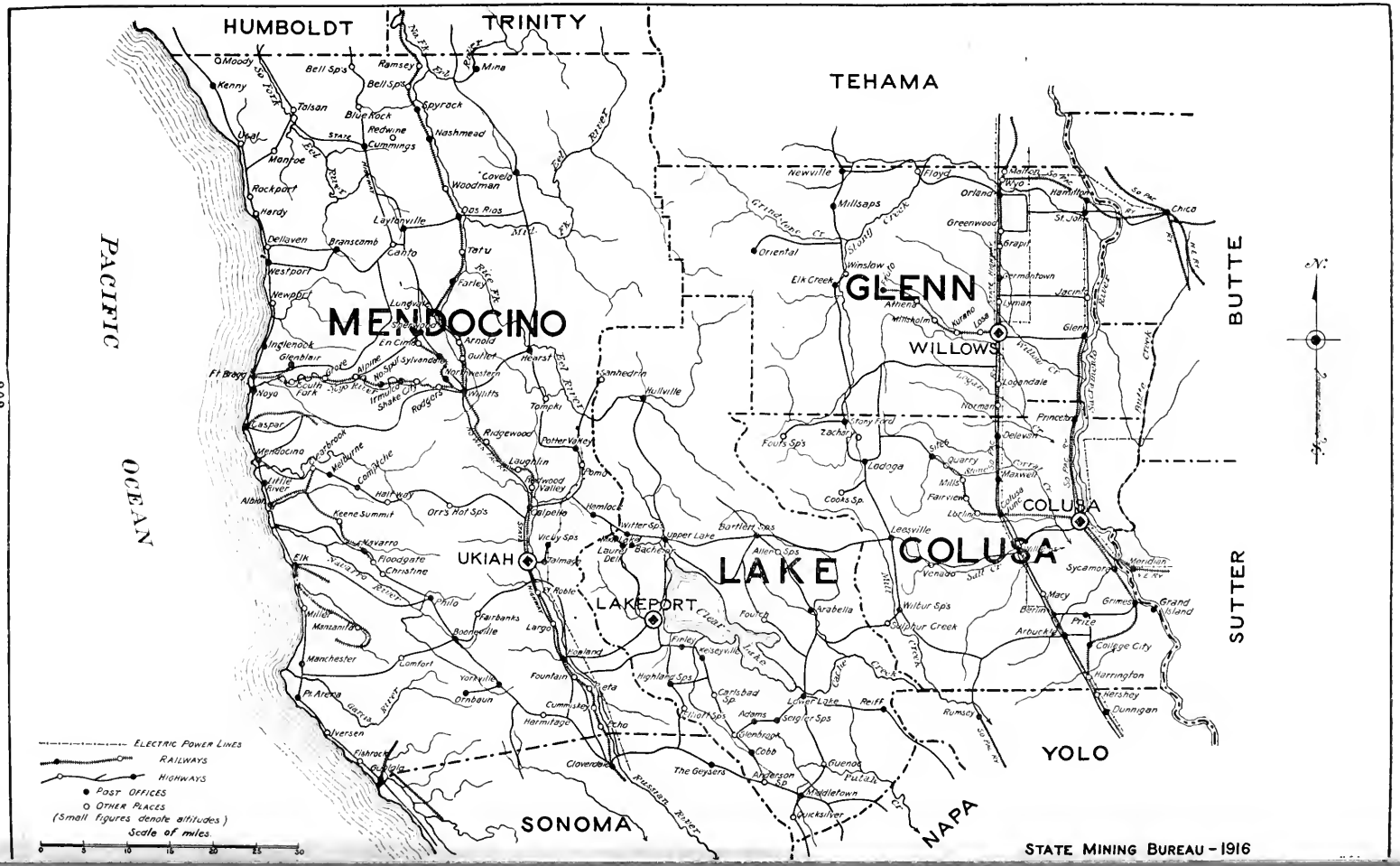
NEVADA
STATE OF
LASSEN
PLUMAS
SIERRA
BUTTE
SHASTA
TEHAMA
GLENN
COLUSA
SUTTER
YUBA
NEVADA
QUINCY
DOWNIEVILLE
OROVILLE
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU - 1916

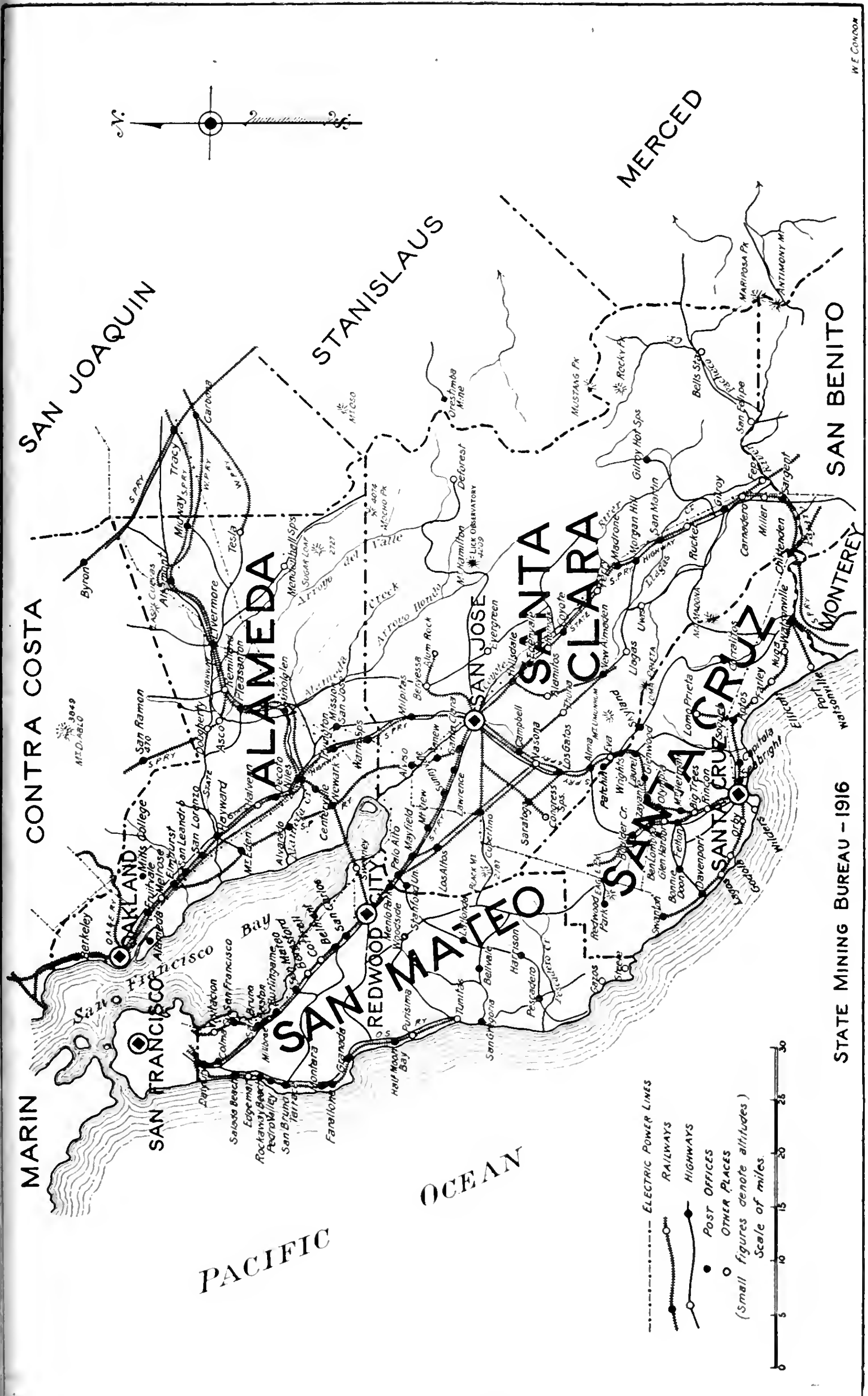

ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
Scale of miles
0 5 10 15 20 25 30
BUTTE
SIERRA
RENO
OROVILLE
COLUSA
COLUSA
YUBA
NEVADA
NEVADA CITY
YUBA CITY
MARYSVILLE
SUTTER
PLACER
AUBURN
EL DORADO
PLACERVILLE
YOLO
WOODLAND
SACRAMENTO
Davis
ALPINE
STATE OF NEVADA
SACRAMENTO
AMADOR
STATE MINING BUREAU - 1916



STATE MINING BUREAU, 1918


ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30
SUTTER
PLACER
YOLO
SOLANO
EL DORADO
AMADOR
ALPINE
STATE OF NEVADA
MARKLEEVILLE
MONO
SACRAMENTO
SACRAMENTO
SAN JOAQUIN
CALAVERAS
TUOLUMNE
JACKSON
SAN ANDREAS
SONORA
STOCKTON
MODESTO
CONTRA COSTA
ALAMEDA
STANISLAUS
MERCED
MARIPOSA
MADERA
YOSEMITE NATIONAL PARK
N.
STATE MINING BUREAU - 1916


HUMBOLDT
TRINITY
TEHAMA
BUTTE
GLENN
MENDOCINO
LAKE
COLUSA
SUTTER
YOLO
NAPA
SONOMA
PACIFIC
OCEAN
WILLOWS
UKIAH
LAKEPORT
COLUSA
Scale of miles.
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes.)
STATE MINING BUREAU - 1916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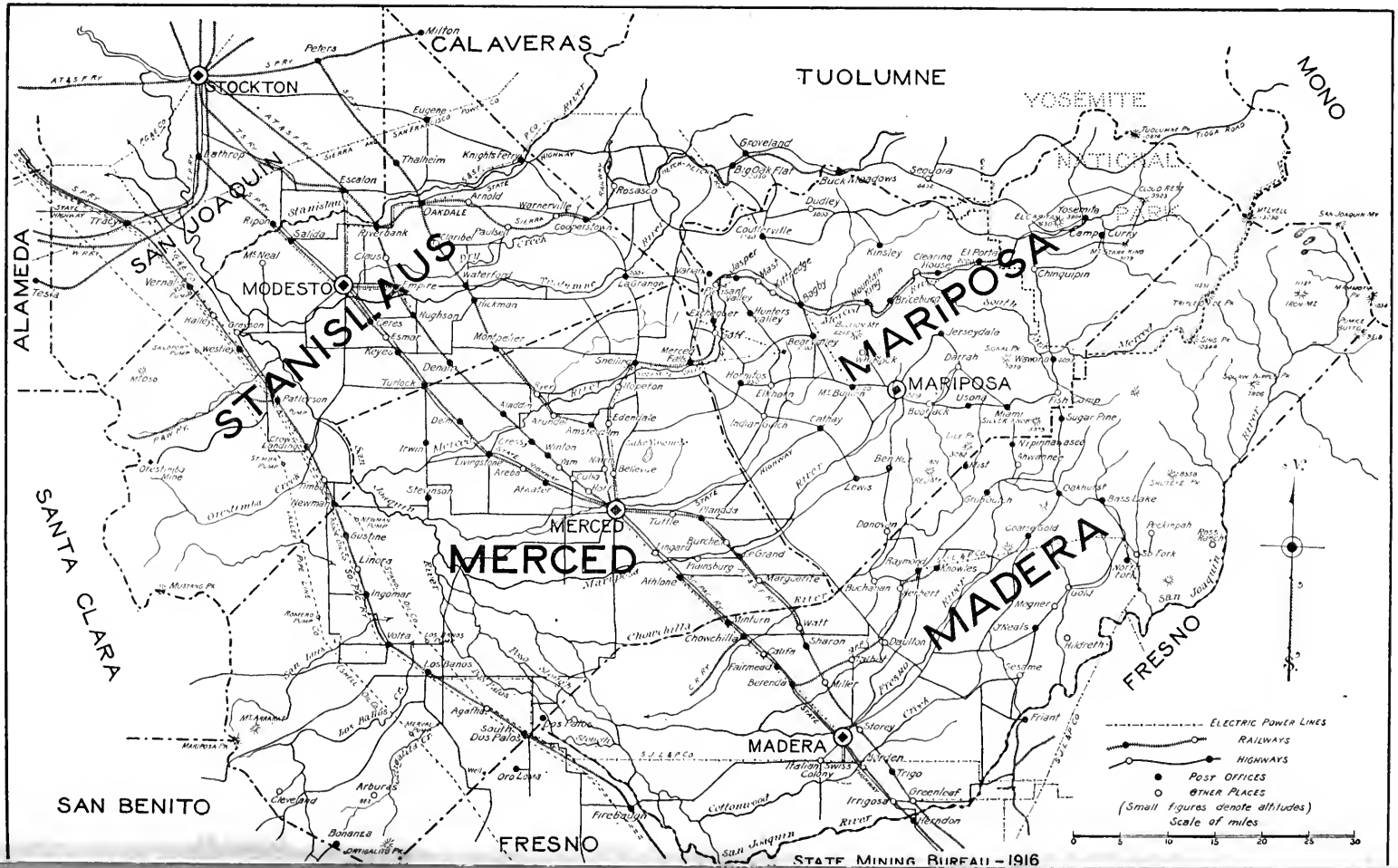
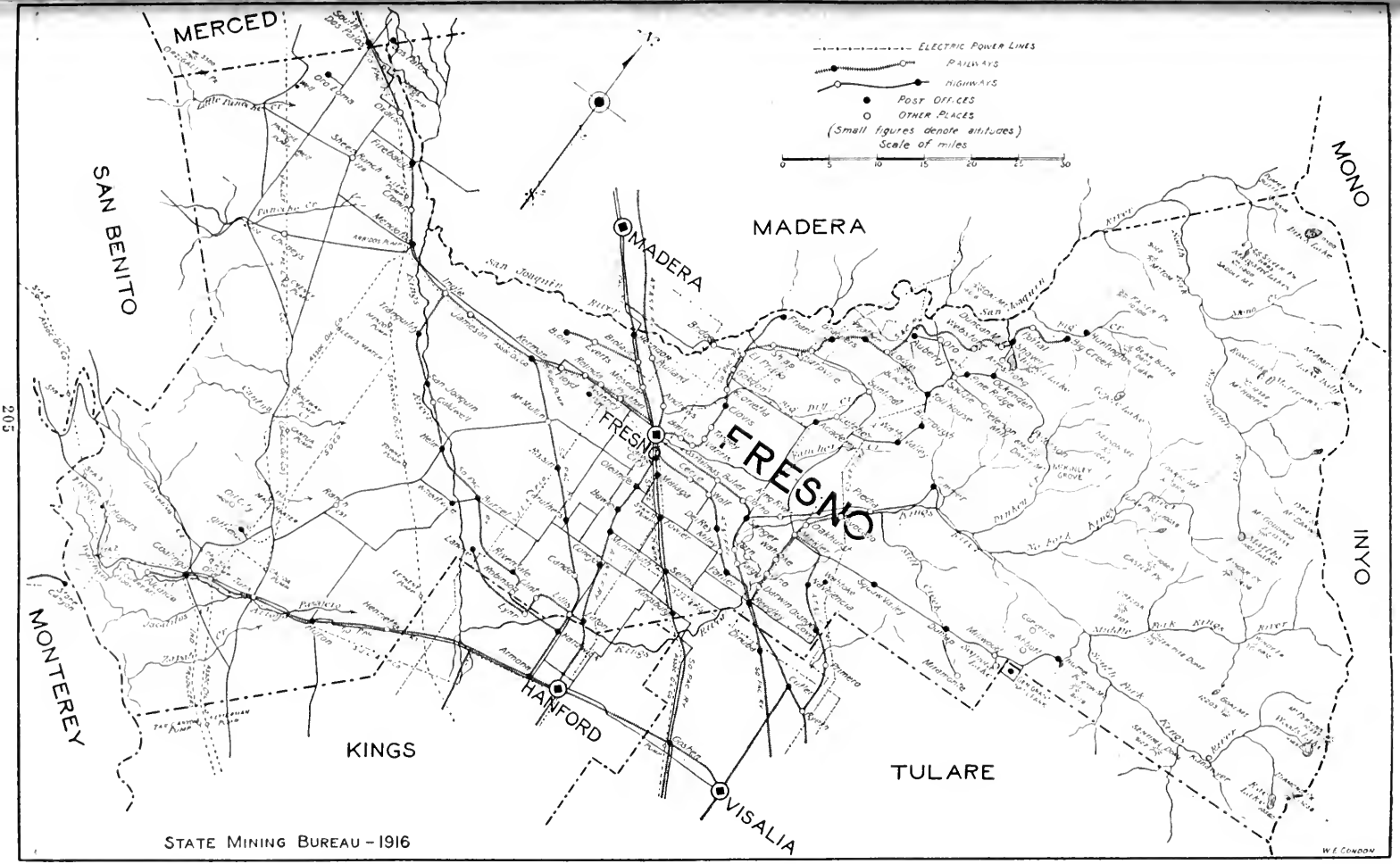
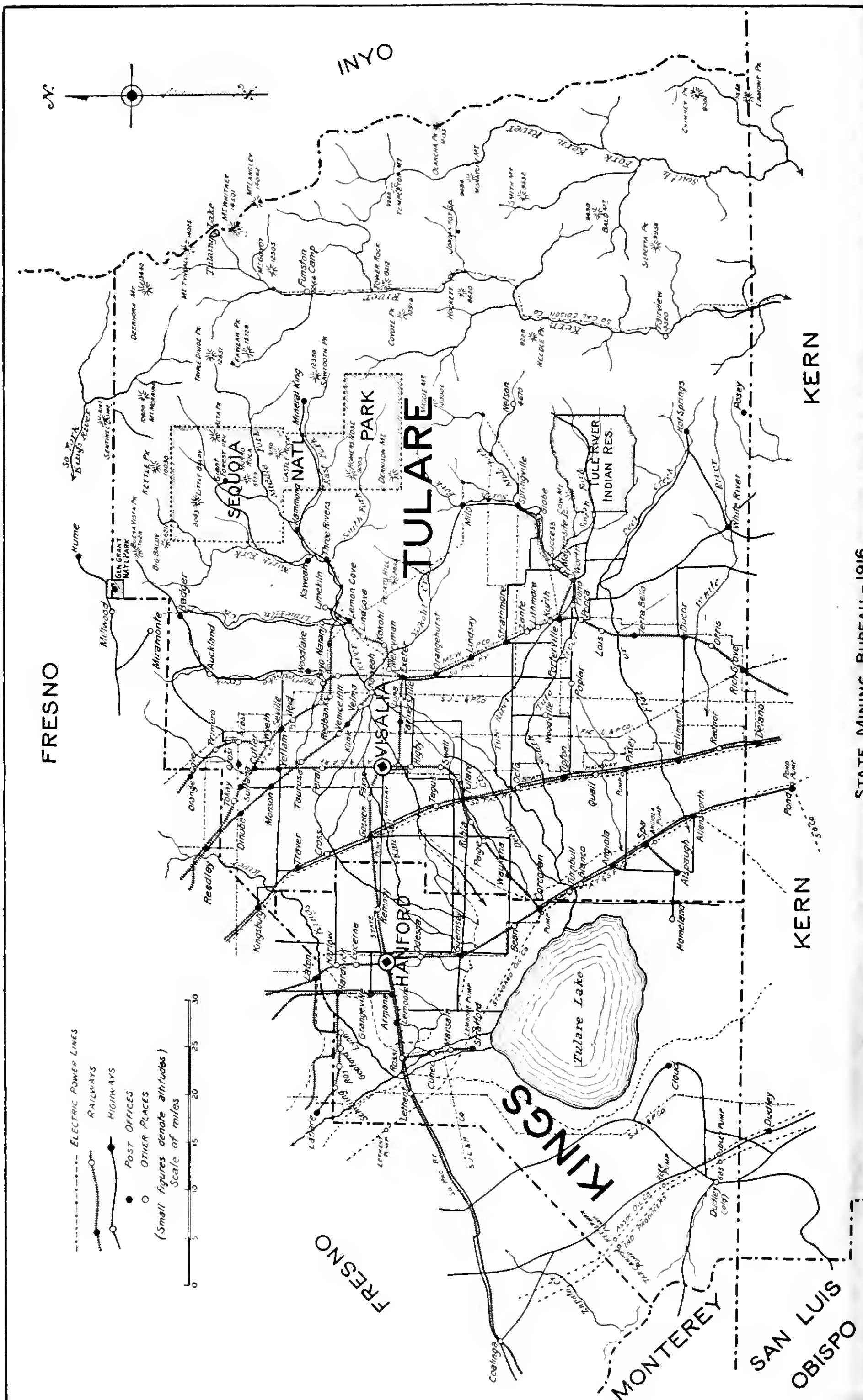
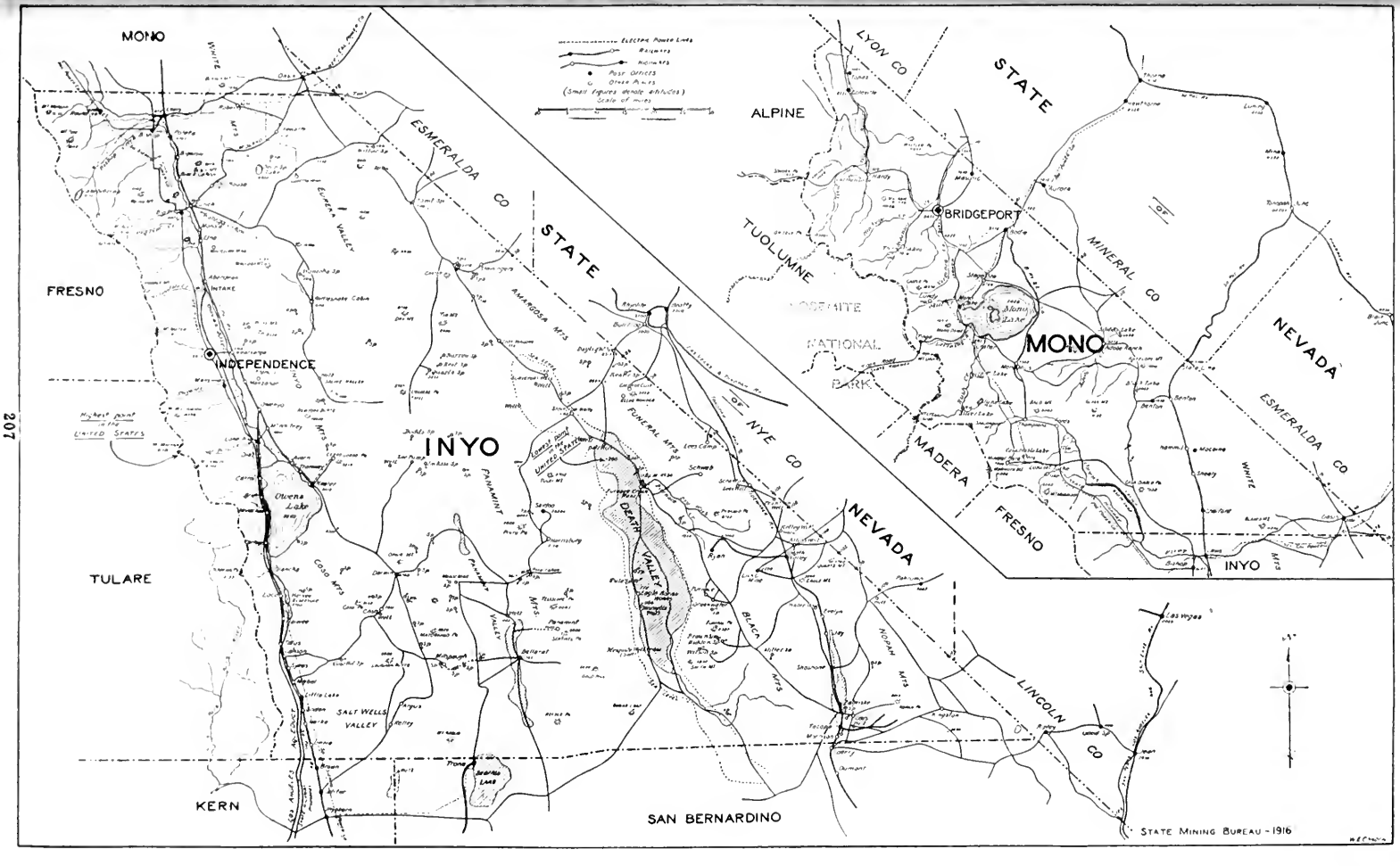
SAN JOAQUIN
STANISLAUS
MERCED
ALAMEDA
SANTA CLARA
SAN MATEO
SANTA CRUZ
SAN BENITO
MONTEREY
SAN FRANCISCO
OAKLAND
SAN JOSE
REDWOOD CITY
San Francisco Bay
PACIFIC OCEAN
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU – 1916
W.E. CONDON

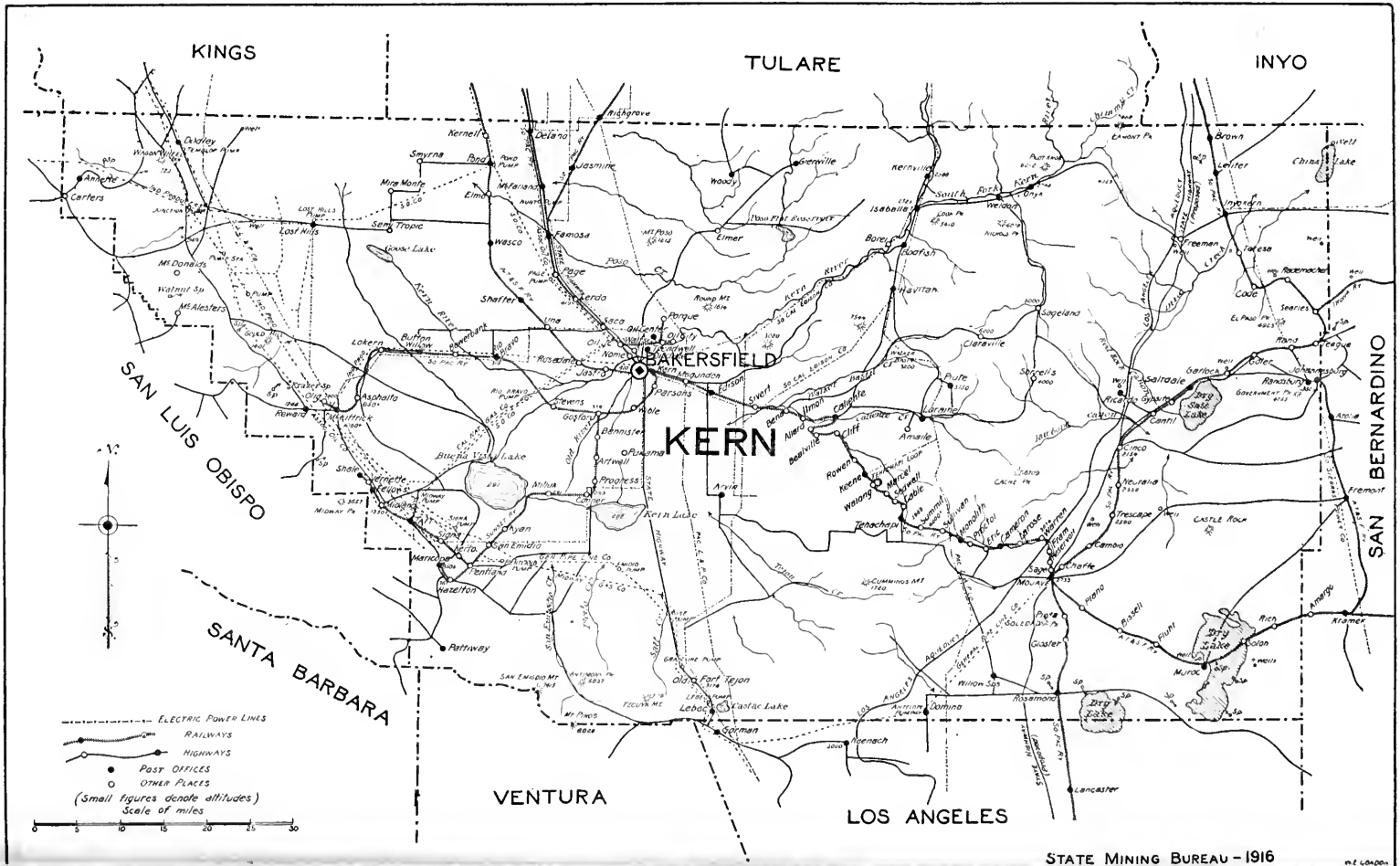

STOCKTON
MODESTO
MERCED
MADERA
MARIPOSA
CALAVERAS
TUOLUMNE
MONO
YOSEMITE
NATIONAL
PARK
STANISLAUS
SAN JOAQUIN
ALAMEDA
SANTA CLARA
SAN BENITO
FRESNO
MERCED
MADERA
FRESNO
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30
STATE MINING BUREAU - 1916

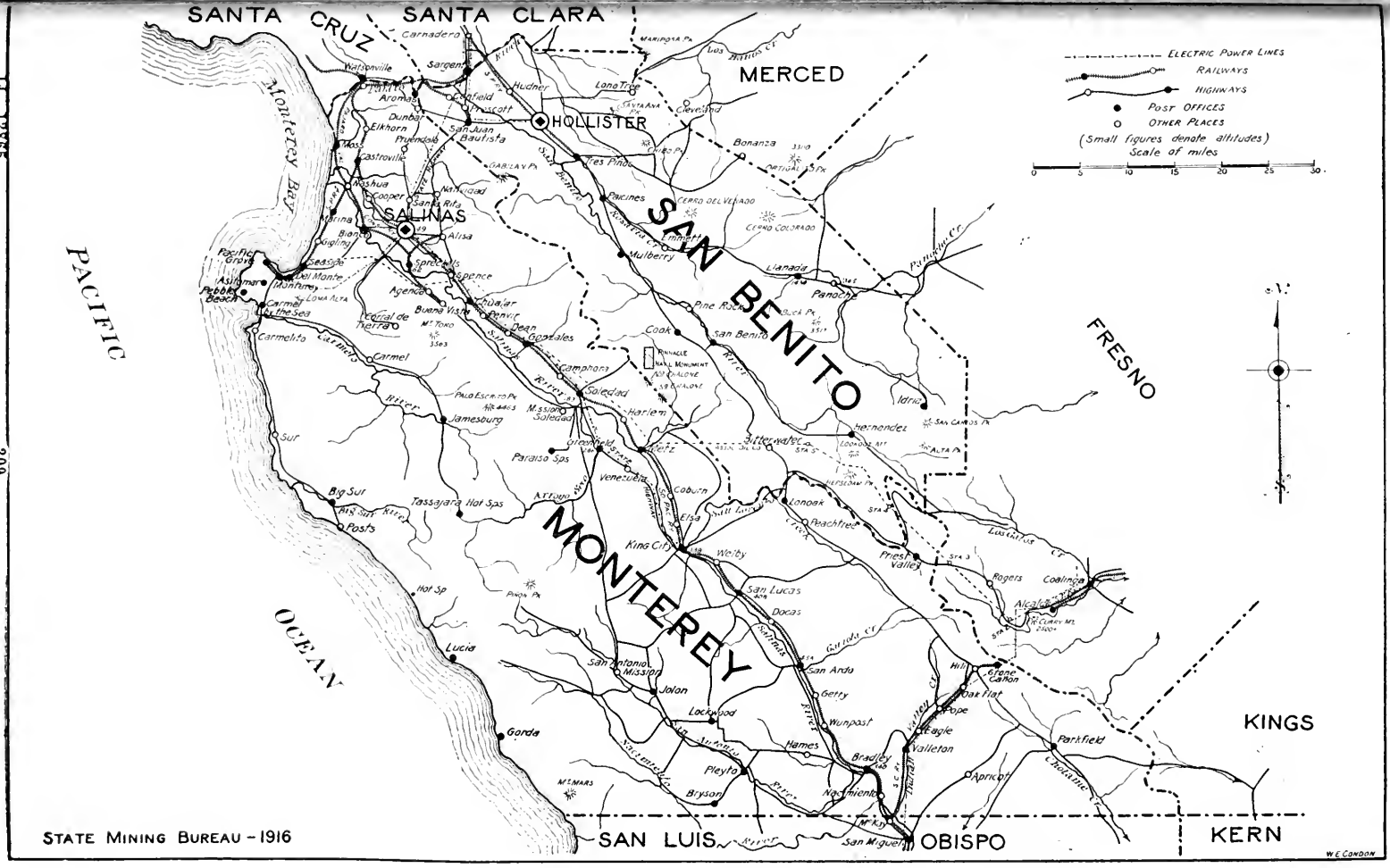

MERCED
SAN BENITO
MADERA
MADERA
MONO
FRESNO
FRESNO
INYO
MONTEREY
KINGS
HANFORD
VISALIA
TULARE
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30
STATE MINING BUREAU - 1916
W.E. CONDON

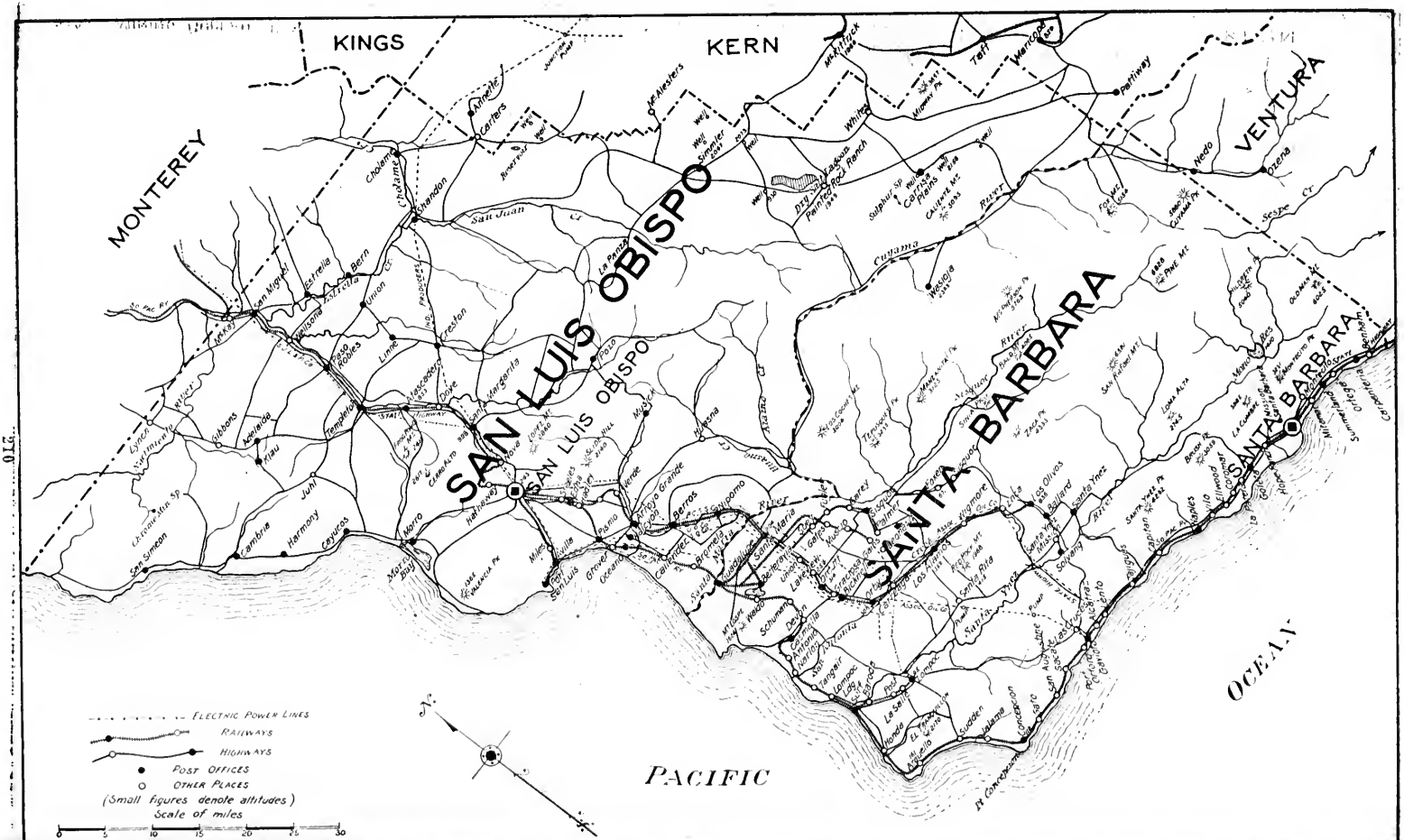


INYO
FRESNO
TULARE
SEQUOIA NAT'L PARK
TULE RIVER INDIAN RES.
KERN
KERN
KINGS
FRESNO
MONTEREY
SAN LUIS OBISPO
Tulare Lake
VISALIA
HANFORD
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0
5
10
15
20
25
30
STATE MINING BUREAU - 1916

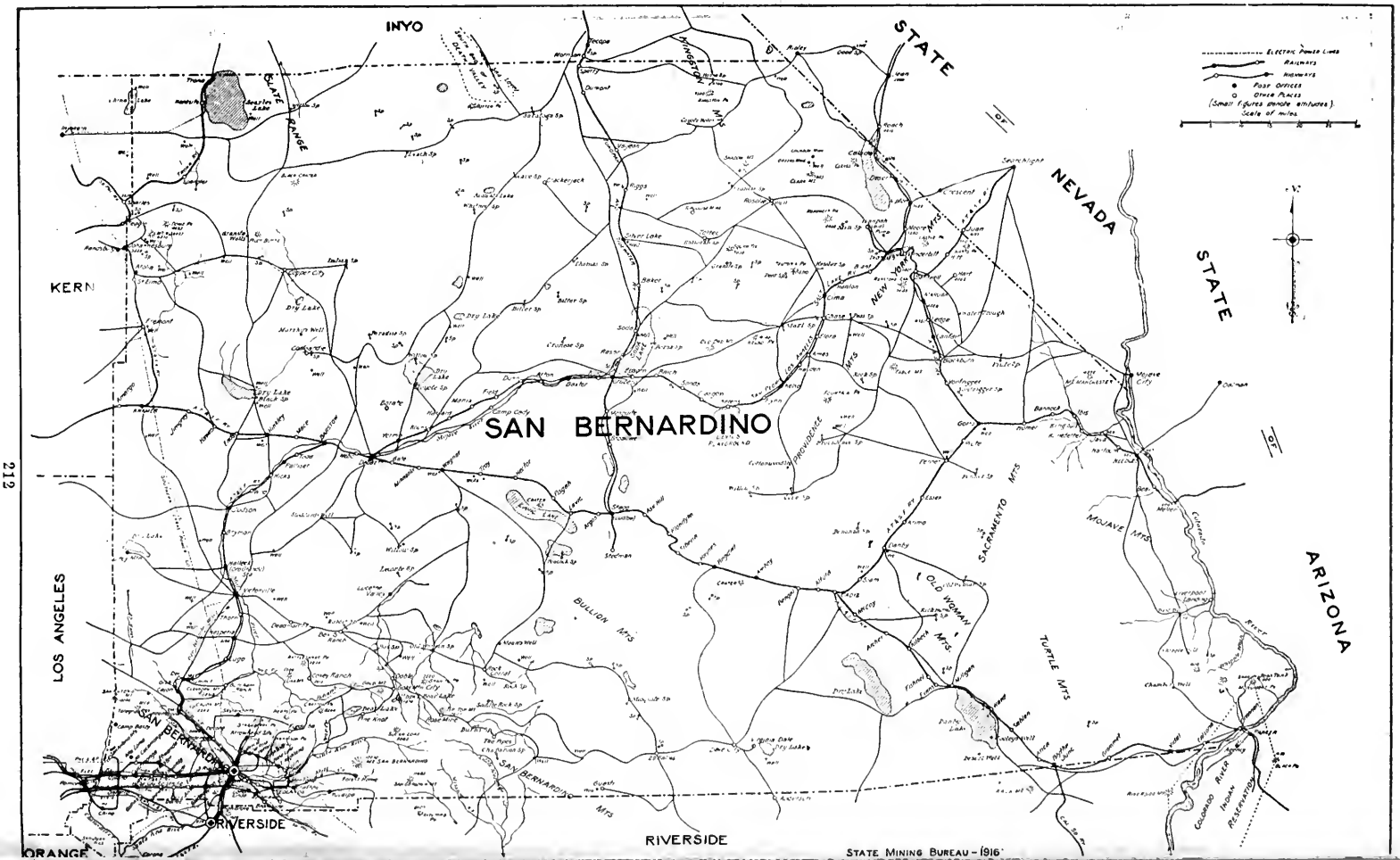

MONO
ESMERALDA CO
STATE
ALPINE
LYON CO
BRIDGEPORT
TUOLUMNE
MINERAL CO
NEVADA
FRESNO
YOSEMITE
NATIONAL
PARK
MONO
MADERA
ESMERALDA CO
INYO
NYE CO
NEVADA
DEATH VALLEY
TULARE
LINCOLN CO
KERN
SAN BERNARDINO
STATE MINING BUREAU - 1916

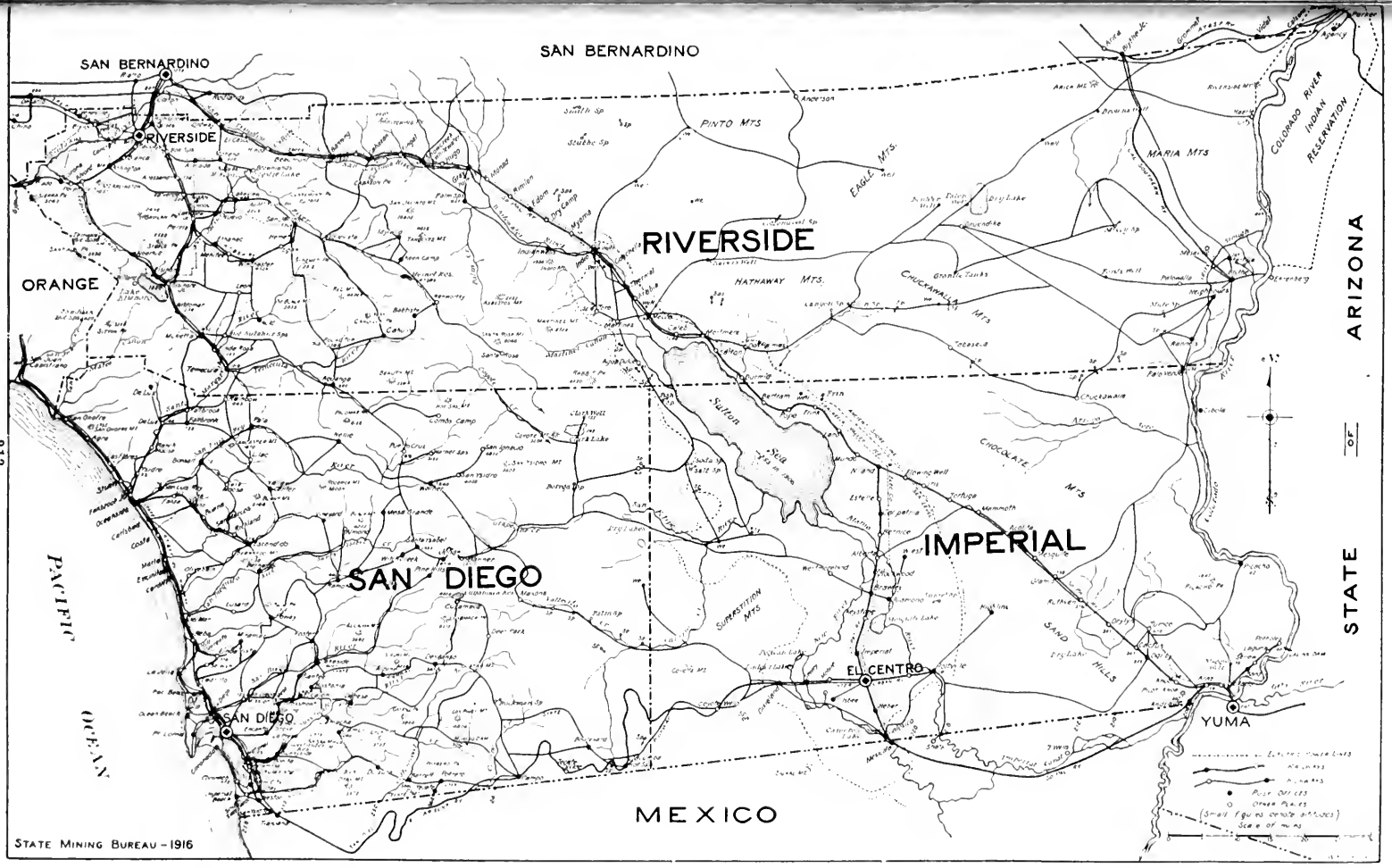

KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
BAKERSFIELD
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30
STATE MINING BUREAU - 1916


SANTA CRUZ
SANTA CLARA
MERCED
SAN BENITO
MONTEREY
FRESNO
KINGS
KERN
SAN LUIS OBISPO
PACIFIC OCEAN
Monterey Bay
HOLLISTER
SALINAS
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30
STATE MINING BUREAU - 1916
W.E. CONDON


KINGS
KERN
MONTEREY
VENTURA
SAN LUIS OBISPO
SANTA BARBARA
SAN LUIS OBISPO
SANTA BARBARA
PACIFIC
OCEAN
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
0 5 10 15 20 25 30


KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SAN DIEGO
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
SANTA ANA
SANTA BARBARA CHANNEL
SANTA CRUZ ISLAND
SANTA ROSA ISL.
ANACAPA ISL.
PACIFIC OCEAN
SAN PEDRO CHANNEL
SANTA CATALINA ISLAND
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU - 1916
W.E. Cowden


INYO
KERN
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SLATE RANGE
NEVADA
STATE
OF
ARIZONA
SACRAMENTO MTS
MOJAVE MTS
BULLION MTS
OLD WOMAN MTS
TURTLE MTS
SAN BERNARDINO MTS
COLORADO RIVER INDIAN RESERVATION
ELECTRIC POWER LINES
RAILWAYS
HIGHWAYS
POST OFFICES
OTHER PLACES
(Small figures denote altitudes)
Scale of miles
STATE MINING BUREAU - 1916


SAN BERNARDINO
SAN BERNARDINO
RIVERSIDE
RIVERSIDE
ORANGE
PINTO MTS
EAGLE MTS.
MARIA MTS
COLORADO RIVER INDIAN RESERVATION
HATHAWAY MTS.
CHUCKAWALLA MTS
CHOCOLATE MTS
ARIZONA
STATE OF
IMPERIAL
SAN DIEGO
SUPERSTITION MTS
SAND HILLS
EL CENTRO
YUMA
SAN DIEGO
PACIFIC OCEAN
MEXICO
STATE MINING BUREAU - 1916

INDEX.

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Saturday, 9 a.m. to 12 m.

FLETCHER HAMILTON,
State Mineralogist

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